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ACKNOWLEDGEMENT

The cover photo was taken in 1972. This area of lodgepole pine regeneration was cut and scarified 15 years earlier in 1957.
The photo was provided by Northwestern Pulp and Power Ltd., Hinton, Alberta.

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THE ENVIRONMENTAL EFFECTS
OF TIMBER HARVESTING OPERATIONS
IN THE
EDSON AND GRANDE PRAIRIE FORESTS OF ALBERTA

VOLUME 1

PROJECT REPORT

SEPTEMBER 1973

For

THE MINISTER OF LANDS AND FORESTS
GOVERNMENT OF ALBERTA
Edmonton, Canada

By

C.D. SCHULTZ & COMPANY LIMITED
Vancouver, Canada

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C. D. SCHULTZ & COMPANY LIMITED

Foresters and Consulting Engineers
Economists and Biological Scientists

325 Howe Street   Vancouver 1, Canada

October 1, 1973
Our File: A53.3.1

The Honorable Allan A. Warrack
Minister of Lands and Forests
Government of Alberta
Natural Resources Building
Edmonton, Alberta

Dear Sir:

We are pleased to submit herewith our report "The Environmental Effects of Timber Harvesting Operations in the Edson and Grande Prairie Forests of Alberta".

This report was prepared in accordance with the Agreement, dated January 26, 1973, between the Government of the Province of Alberta and C.D. Schultz & Company Limited, and in accordance with subsequent instructions received.

We trust that the report will be of assistance in reaching management decisions concerning this important forest region.

Yours truly,

C.D. SCHULTZ & COMPANY LIMITED

RE Breadon

R.E. Breadon, R.P.F.
Project Manager

C.D. Schultz

C.D. Schultz, R.P.F., P.Eng.
President

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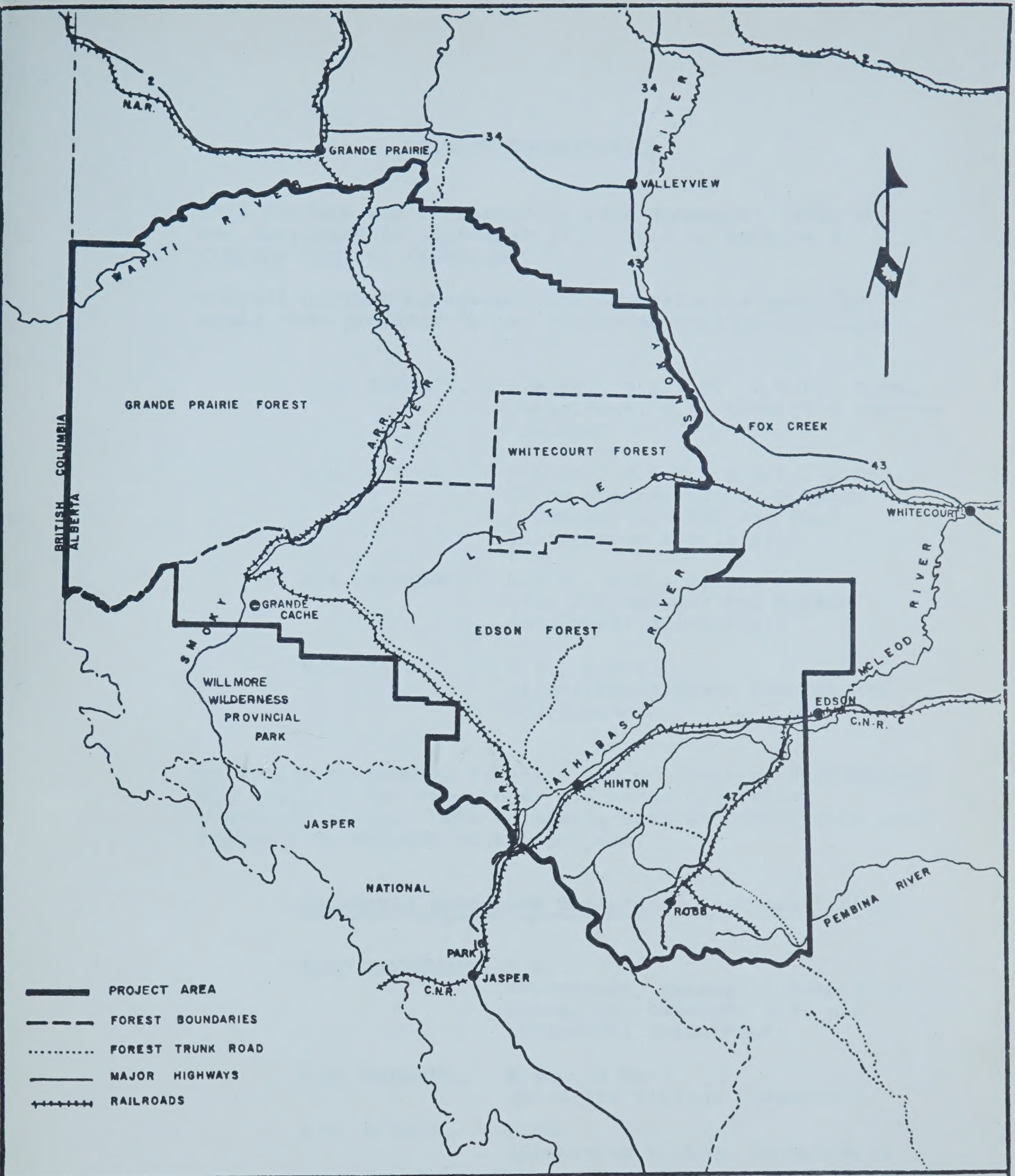
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RAILROADS

KEY MAP

PROJECT No. A53.3.1 | DWG No. 38A | SCALE 1" = 25 mi | DATE JULY 1973

GOVERNMENT OF ALBERTA

C.D. SCHULTZ & COMPANY LIMITED

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PROJECT ORGANIZATION

This project was initiated in late November, 1972, and was completed in September 1973, by C.D. Schultz & Company Limited (Schulco).

Overall project management and expertise in specific areas were provided by the following Schulco personnel:

C.D. SCHULTZ,	B.A.Sc., M.E.I.C., R.P.F., P.Eng. (President, C.D. Schultz & Company Limited)
R.M. SITTER,	B.A.Sc., M.B.A., R.P.F., P.Eng. (Vice President, C.D.Schultz & Company Limited and Road Engineering Specialist)
R.E. BREADON,	B.S.F., M.F., R.P.F. (Project Manager and Forest Management Specialist)
M.G. PAHL,	B.A., M.B.A. (Assistant Project Manager and Coordinator)

Expertise in several forestry and nonforestry disciplines was required for the proper discharge of project responsibilities. The following Special Consultants were employed by Schulco on the project:

Renewable Resources Consulting Services Limited

R.D. JAKIMCHUK,	B.A. (President, Renewable Resources Consulting Services Ltd. and Ecological Consultant)
K.H. McCOURT,	B.Sc., M.Sc. (Wildlife Biology Consultant)
J.P. O'NEIL,	B.Sc. (Fisheries Biology Consultant)
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Bayrock Surficial Geology Limited

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L.J. MILNER,	B.S.F., R.P.F. (Forest Management and Harvesting Consultant)
L.L. ADAMOVICH,	M.F., P.Eng. (Forest Roads and Transportation Consultant)
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D.R.M. SCOTT,	B.A., M.F., Ph.D. (Silviculture Consultant)
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W.H. POLIQUIN,	B.Sc., M.Sc. (Forest Hydrology Consultant)
P.J. DOOLING,	B.Econ., M.Phys. Ed., Ph.D. (Forest Recreation Consultant)
J.L. LANTZIUS,	B.Sc., M.L.Arch. (Landscape and Aesthetics Consultant)

The contributions of these Consultants to the Project are sincerely acknowledged.

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ACKNOWLEDGEMENTS

Apart from direct field observation, basic data for this project were obtained from information and records kept by Alberta Government Offices. This information and accompanying explanations were freely made available to the Consultants. Alberta Forest Service personnel at Edmonton, Grande Prairie, Whitecourt, Edson, and several Forest Ranger and Forest Lookout Stations were most helpful in this regard, as were the personnel of the Alberta Government Departments or Branches with jurisdiction over environmental protection, fish and wildlife, forest land use, highways, parks and campsites, and several related fields. This same cooperative spirit was shown in consultations with the many representatives of the forest industry, including especially those of North Western Pulp and Power, North Canadian Forest Industries, Procter & Gamble, Imperial Lumber, Erith Tie Company, and the Alberta Forest Products Association.

Discussions held with representatives of the Northern Forest Research Center, the Canadian Wildlife Service, the Alberta Research Council, the University of Alberta, the Peace River Regional Planning Commission, the Alberta Fish and Game Association, the Wild Kakwa Association, the Alberta Wilderness Association, and S.T.O.P. were most helpful in defining major issues and polling opinions concerning land use alternatives. The process of reconciling land management aims during this project was undoubtedly influenced by these contacts, and by less formal contacts with many other individuals and groups.

PREFACE

This report is based to an unusual degree upon the exercise of subjective judgement not easily verified by simple facts or measurements.

C.D. Schultz & Company Limited acknowledges full responsibility for the contents of this report, including the opinions expressed. These opinions do not necessarily coincide with those of the Alberta Government nor with those of any other public or private agency.

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THE ENVIRONMENTAL EFFECTS
OF TIMBER HARVESTING OPERATIONS
IN THE
EDSON AND GRANDE PRAIRIE FORESTS OF ALBERTA

INTRODUCTION

This Study was initiated to examine the forest management practices employed under various tenures within a designated project area. This area includes an important segment of Alberta's forest resources, and exhibits ample potential for conflicts in land use objectives.

The project area (see Key Map) includes major portions of the Grande Praire and Edson Forests, and a lesser portion of the Whitecourt Forest. This area produces about 35 percent of the timber currently cut in Alberta. It is the basis for all existing pulpmill production in the Province, and includes three major Forest Management Areas (FMA's) of the four in Alberta. These Forest Management Areas typify forest management commitments for support of large, permanent plants. Various smaller or more temporary timber allocations complement the FMA's. A cross-section of Crown and Industry forest management in Alberta is thus observable within the area. Some agriculture, major coal, oil, and gas extraction, and a variety of secondary industries also occur within the area. Specific habitat, recreational, and scenic values, complementary to those afforded by adjacent provincial and national parks, must also be reconciled with industrial uses.

The terms of reference of the project called for examination of the forest management practices required by the Government, the extent to which requirements are now met, the effects on land productivity and environmental values, the identification of significant problem areas, and the adjustments which could overcome any such problems. These terms of reference were applied respectively in each of the following separate fields:

- road systems (including planning, location, construction, maintenance, and use);
- timber harvesting (including forest management, cutting patterns, and harvesting methods and economics);

- reforestation (including silvicultural practices for the establishment and tending of forest crops following initial cutting).

The costs of forest operations under any recommended modifications are compared with current costs.

Since the project deals with the effects of timber harvesting (under Government standards) on the environment, precise definitions of the terms "timber harvesting", "environment", and "Government requirements" are needed. For purposes of this project, the definitions are:

- "Timber Harvesting". This includes all activities concerned with the cutting and delivery of roundwood to central manufacturing plants. The environmental effects of manufacturing processes and further stages are excluded from the project, and no modifications of manufacturing methods are proposed. With respect to the economics of industries dependent on timber harvesting, selling prices and various costs of production are predicted, but only to complete an economic framework within which timber harvesting costs can be judged.

- "Environment". The environment is the sum of natural, aesthetic, commercial, and convenience values found in the area in its present, relatively wild, state. Most human activities produce small or great changes in this environment. The "environmental effect" of these activities is assumed to be the extent of disturbance or modification of the existing environment. Practices which mimic all but the most catastrophic natural processes are, by this reasoning, less damaging than practices which do not.

- "Government Requirements". These are current requirements as enforced by the Government and applied by operating companies. Past requirements, and the observed effects of them, are not under direct scrutiny.

Most of the area is owned by the Crown and much is presently committed to sustained production of timber crops as a primary land use. Alternative land-uses are in effect on portions of the area and further alternative uses will be proposed from time to time. Ideally, these public lands must continue to support expanding forest industries (the primary land-use) while maintaining a quality environment for water yield and wildlife habitat, and while accommodating new industrial and municipal development, traditional forms of livelihood, and appropriate outdoor recreation opportunities. The purpose of this project is to determine how forest management practices can best contribute to achievement of these combined objectives.

This project, because of its interdisciplinary nature, required contributions from an authoritative team of specialists expert in many areas. Detailed discussions and extended field trips were also necessary. A partial listing of these may be found in Progress Reports submitted monthly throughout the project.

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CHAPTER I

1.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A lengthy series of conclusions and recommendations are presented in Chapter V, following descriptions and analyses contained in Chapters II, III, and IV. A brief summary is given here to furnish overall perspective.

1.1 Conclusions

1. Many elements of the total environment, important in the project area, are affected in complex ways by an even larger number of identifiable activities or events associated with timber harvesting. An extremely large number of interactions thus occur. Of these, a few are considered environmentally beneficial, many are of minor importance, some present moderate environmental threats, and a relatively small number present major environmental threats.

2. Zones differing widely in suitability for various land uses and in susceptibility to various environmental threats are identifiable in the project area. Overlay maps accompanying this report broadly outline the principal zonations of the kind needed for future planning.

3. Timber harvesting can remain as a principal and highly legitimate use of the project area. In many cases, trade-offs between this use and competing uses are feasible and would avoid conflicts without major sacrifice.

4. Curtailment of cutting on selected sites is desirable for protection of watershed, habitat, or aesthetic values. Most of these sites are of marginal timber productivity. It is believed that a newly-calculated coniferous allowable annual cut of the remaining area, based on modern forest inventory data and modern management assumptions, would be at least as great as that presently ascribed to the entire project area. Thus the curtailments foreseen probably necessitate no reduction in net allowable cut for the area, and certainly necessitate no reduction in presently committed annual cutting.

5. Environmental damage associated with roads, both during and after construction, is far greater than that associated with all other phases of harvesting. Much damage caused by roads is localized at stream crossings, but effects on soil, watershed, game and aesthetic values occur throughout. Much of the damage presently occurring could be reduced in future by nothing more elaborate than planning, supervision, and attention to detail on the ground.

6. The observed immediate effects of harvesting, with minor exceptions, are less harmful than those for roads, at least until areas at higher elevations are reached. The importance of the project area for big game habitat and scenic values suggests improved planning to avert threats to these values.

7. Regeneration of new crops, if successful, has almost no harmful effects on the environment. Delay or failure of prompt restocking on the contrary threatens almost every environmental element considered important on the project area. Performance to date has been below expectation, and must be improved.

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8. The requirements under which harvesting operations will be conducted from now on are basically sound from the forest management, economic, and environmental points of view. Nevertheless several adjustments to these requirements are recommended to assure greater coordination of all land use needs.

9. Many of the above requirements are of recent origin. It appears that additional staffing, training, and broadening of responsibility will be necessary in the Forest Service for assurance that the requirements will be properly implemented.

1.2 Recommendations

Detailed recommendations are given in Chapter V. They are intended to provide a transition from pure forest management to something broader, the management of forest lands. Many detailed recommendations, despite this, still relate to pure forest management. In keeping with Conclusion Number 9 above, many of the recommendations made are directed towards implementation of existing requirements, rather than creation of new ones.

1. A series of Forest Management recommendations are made. These reflect:

    - a need to expand Forest Service staff and improve conditions for continuity and efficiency;
    - a need for substantial updating of forest inventory, management planning, and mapping of land capability for several related uses;
    - a need for greater cooperation and liaison among all interested parties so as to improve land use planning and research;
    - a need for leadership from the Department of Lands and Forests as the main authority responsible for land use planning on the project area. This responsibility would necessitate consultation with other departments. Procedures which would formalize greater contact with these other departments are suggested.

2. A series of recommendations concerning Forest Hydrology and Wildlife Management are made. These include:

    - deletion of marginal forest lands from normal cutting, for the protection of watershed, scenic and wildlife values;

    - monitoring of stream flows and water quality, with the objective of developing quantitative standards by which impairment or improvement of these could be measured;

    - adoption of the criterion that 90 percent of the area of critical watersheds be kept vegetated at all times, rather than the less positive criteria now in effect;

    - identification of "special game areas" containing key habitat of the main big game species, and special modifications to timber harvesting practices on these areas.

3. Recommendations concerning Road Systems are lengthy. These include:

    - better planning and standardization of road systems in the project area;

    - closer attention to details of construction of all kinds, particularly where roads are in contact with streams;

    - measures for prevention of deterioration of watersheds, fish habitat, game habitat, and aesthetic values.

4. Recommendations concerning harvesting include:

    - creation of incentives for utilization of the pulpwood component of all trees cut;

    - increased inspection, reporting, and supervision of harvesting operations by the Forest Service;

- no sweeping change in clearcut pattern, size, shape, or timing until the results of existing requirements can be assessed.

- improvements in the recruitment and training of woods labor;

- introduction of appropriate methods and equipment for harvesting of steep or sensitive terrain.

5. Recommendations concerning Regeneration and Silvicultural Practices include:

   - close Forest Service attention to reforestation programs of timber quota holders which are currently at an early stage of development;

   - initiation of research programs to determine the effectiveness of present restocking methods and standards;

   - expansion of surveys to determine restocking success under varying conditions;

   - provisions for the testing of alternative cutting and treatment systems on a localized and controlled basis;

   - advance testing of systems for partial cutting which may be of importance in protection of non-timber values at certain specific sites;

   - continued testing of seeding and planting techniques until satisfactory and lasting results can be consistently obtained.

6. Recommendations concerning aesthetic and recreation values include:

   - budgeting, training and other support for an expanded forest recreation area program;

   - identification of prime sites along travel corridors in advance of harvesting development;

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- proposals for reservation or development of known sites.

1.3 Reconciliation of Operating Costs

Current costs of the various types of harvesting operation are estimated. The additional cost associated with recommended changes also are estimated. In comparison with returns presently experienced by industry, neither current nor recommended practices appear to be beyond the financial capacity of industry. Furthermore, existing technology appears adequate to implement all recommendations.

CHAPTER II

2.0 DESCRIPTION OF EXISTING ENVIRONMENT

2.1 Physiography and Surficial Geology

The project area encompasses approximately 13,400 square miles (8.6 million acres) of the Alberta Plateau and the Foothills. Local relief throughout the area is highly variable. The northern and northeastern portion is essentially level, with incised riverbeds. The central portions include glaciated Tertiary erosion remnants forming large plateaux with steep flanks. The Foothills in the western portion of the area rise to steep and broken terrain, with peaks over 8,000 feet in elevation in the Canadian Rocky Mountains.

This variety in terrain necessitates identification and mapping of the different elements influencing land management. The Soil Stability Overlay in Volume 2 was prepared for this purpose. Published or manuscript maps showing surficial geology for portions of the area were reproduced, in somewhat simplified form and at 1:250,000 scale. The adjacent unmapped portions of the area were then mapped from aerial photographs. Within the limitations of the mapping scale, subsequent field examinations confirmed the map descriptions and locations of surficial deposits.

2.1.1 Subsurface Geology

Bedrock formations underlying the project area are shown in Figure 2.1. East of the Foothills, these form part of the Alberta Syncline; in the Foothills, anticlinal ridges and thrust faults are common. Classified by age, bedrock formations are:

Paleozoic. Paleozoic rocks, mainly limestones, occur on the upper ridges and summits southwest of Hinton.

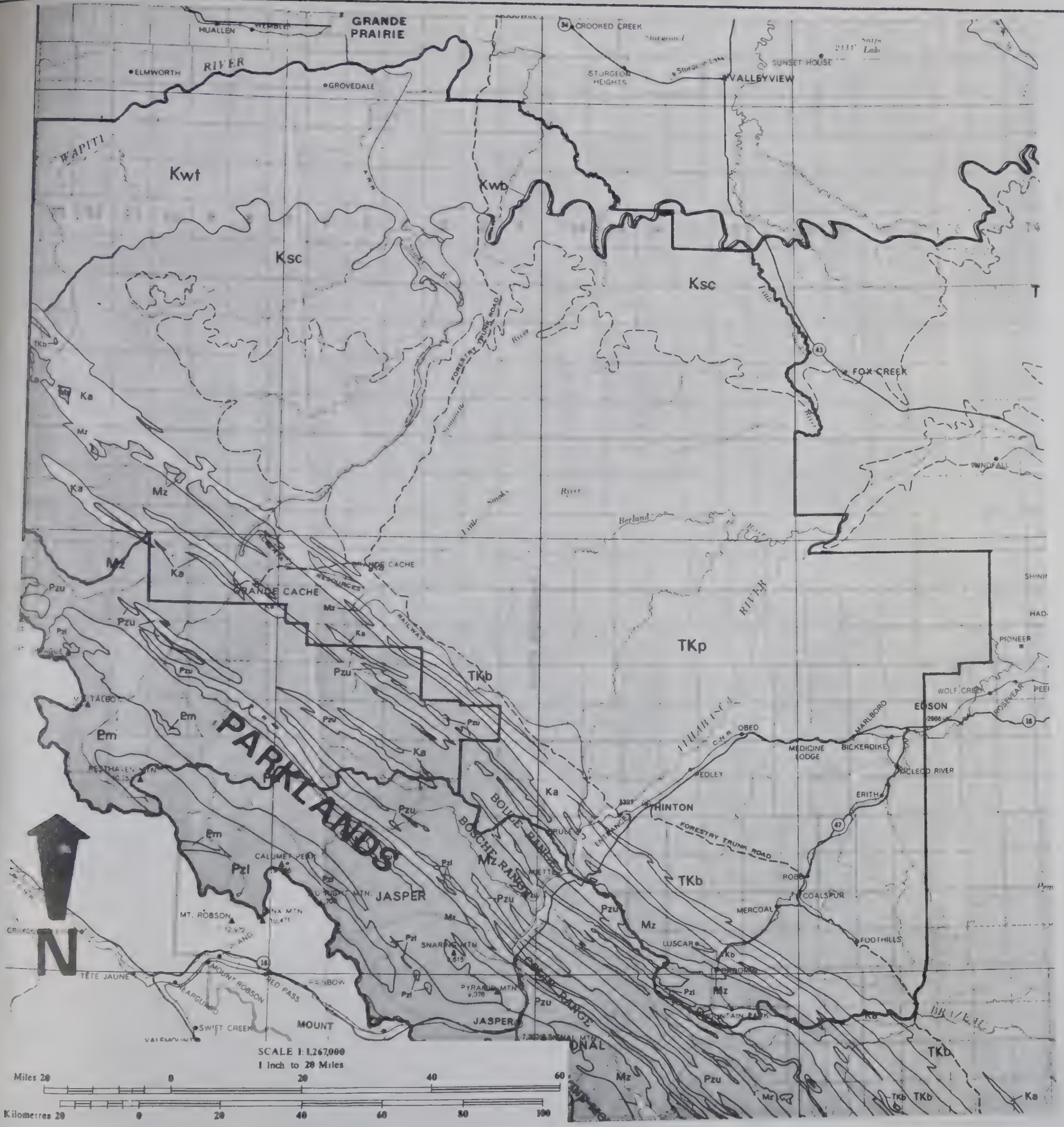
Mesozoic. These are sedimentary rocks, mainly sandstone, siltstone and shale, with occasional coal strata. Most of these rocks are partially consolidated, but weather readily to fine-grained deposits.

Tertiary. The Wapiti Formation is mainly of Tertiary age, and is largely indurated with carbonates which retard weathering.

Tertiary gravel deposits lie at or near the surface on many of the plateaux, particularly in the east-central part of the area. These are coarse textured and consist of well rounded pebbles, cobbles, and boulders, probably deposited in Oligocene time by large, fast-flowing rivers rising in the newly-formed Rocky Mountains. The major lithology of these gravels is quartzite, derived from the Precambrian Formations of the Rockies.

2.1.2 Surficial Deposits

Surficial deposits in the area result largely from multiple glaciation during the Pleistocene Age. The last Continental glacier advanced from the northeast in "Classical Wisconsin" times and covered most of the terrain up to the 5000-foot contour. Cordilleran glaciers flowed from the Rocky Mountains and occupied major river valleys.


GRANDE PRAIRIE
HUALLEN
WEMBLEY
ELMWORTH
RIVER
GROVEDALE
CROOKED CREEK
STURGEON HEIGHTS
VALLEYVIEW
SUNSET HOUSE
WAPITI
Kwt
Kwb
Ksc
Ksc
FOX CREEK
WINDFALL
Ka
Mz
Pzu
Pzl
Pm
GRANDE CACHE
TKp
TKb
PARKLANDS
JASPER
MT. ROBSON
TETE JAUNE
MOUNT ROBSON
VALEMOUNT
SWIFT CREEK
HINTON
EDSON
OBED
MEDICINE LODGE
BICKERDIKE
MARLBORO
WOLF CREEK
PEDLEY
ERITH
MCLEOD RIVER
POBE
COALSPUR
MERCOAL
LUSCAR
FOOTHILLS
FORESTRY TRUNK ROAD
PIONEER
N
SCALE 1:1,267,000
1 Inch to 20 Miles
Miles 20
0
20
40
60
Kilometres 20
0
20
40
60
80
100

BEDROCK GEOLOGY MAP OF ALBERTA FORESTRY STUDY

From: Green, R. (1972): Geological Map of Alberta; Research Council of Alberta, Map 35.

LEGEND

TERTIARY AND CRETACEOUS

PALEOCENE AND UPPER CRETACEOUS

TKb	**BRAZEAU FORMATION**: greenish grey, thick-bedded, chloritic and feldspathic sandstone and blocky grey mudstone; some tuff and thin coal beds; nonmarine
TKp	**PASKAPOO FORMATION**: grey to greenish grey, thick-bedded, calcareous, cherty sandstone; grey and green siltstone and mudstone; minor conglomerate, thin limestone, coal and tuff beds; **Scollard Member (Ksc)**: grey feldspathic sandstone, dark grey bentonitic mudstone; thick coal beds; nonmarine
Kwb	**WHITEMUD AND BATTLE FORMATIONS**: pale grey, white-weathering, bentonitic sandstone and mudstone (Whitemud Formation)—purplish black, mauve-weathering, bentonitic mudstone containing siliceous tuff beds (Battle Formation); nonmarine
Kwt	**WAPITI FORMATION**: grey, feldspathic, clayey sandstone; grey bentonitic mudstone and bentonite; scattered coal beds; nonmarine

CRETACEOUS

Ka	**ALBERTA GROUP**: dark grey, fissile, silty shale; some thin-bedded, fine- to medium-grained, cherty sandstone (Blackstone Formation)—thick-bedded, well-sorted, quartzose sandstone; dark grey shale and carbonaceous shale; siltstone and thin coal beds (Cardium Formation)—dark grey fissile shale and siltstone; thin-bedded, fine-grained, glauconitic sandstone; thin beds of concretionary ironstone (Wapiabi Formation)—Note: north of Athabasca River areas designated as **Ka** include Smoky Group, Dunvegan and Shaftesbury Formations (stratigraphic equivalents of Alberta Group)

MESOZOIC

Mz	**LOWER CRETACEOUS, JURASSIC AND TRIASSIC**: dark grey to black siltstone; dolomitic siltstone and limestone; silty dolomite, limestone, breccia and gypsum (Triassic)—dark grey to black fissile shale and siltstone; black cherty and phosphatic dolomite and limestone; green glauconitic shale and sandstone (Jurassic)—thick-bedded, fine- to coarse-grained, cherty sandstone interbedded with dark grey shale, siltstone and coal (Nikanassin and Kootenay Formations)—grey, siliceous, calcareous sandstone; green chloritic and feldspathic sandstone; dark grey carbonaceous and calcareous shale; grey, green, and red shale and silty shale; some conglomerate; coal in central and northern Foothills; trachytic tuff, agglomerate in southern Foothills (Blairmore Group)

PALEOZOIC

Pzu	**UPPER PALEOZOIC**: grey argillaceous limestone and dolomite, in part cherty and stromatoporoidal, in part coarsely biostromal; black nodular and calcareous shale; grey to brown aphanitic to finely crystalline limestone, dolomite-mottled limestone, and dolomite; black bituminous shale (Upper Devonian)—dark grey fissile shale, siltstone, argillaceous limestone and cherty limestone; medium- to coarse-grained crinoidal limestone, cherty and dolomitic limestone; dolomite, cherty dolomite, anhydrite, red shale and sandstone (Mississippian)—thin- and thick-bedded quartzose sandstone, phosphatic quartzose siltstone, silty and cherty dolomite, chert and cherty carbonate (Pennsylvanian-Permian)
Pzl	**LOWER PALEOZOIC**: thick-bedded, grey, pink and purple quartzite and quartzose sandstone, with shale and limestone lentils (Gog Group)—pale grey thick-bedded dolomite and limestone; dark grey, fine-grained, thick- to thin-bedded limestone and dolomite; maroon, buff and green, calcareous and siliceous shales; local intraformational conglomerates (Middle and Upper Cambrian)—grey to grey-green limestone, shaly limestone and shale, local intraformational conglomerate; pale grey to pale brown, medium-bedded, siliceous dolomite; clean white quartzite (Ordovician)—pale grey and yellowish grey, medium-bedded, fine-grained dolomite (Silurian)

Deposits now found can be traced to the advancement, melting or damming actions of these glaciers on the pre-Wisconsin landforms.

After some simplifications to combine deposits of similar properties, the important surficial deposits are classified and described in Table 2.1. The estimated percentage of the project area covered by each is also shown. Of the 14 classes listed, 12 occur on productive forest lands designated for eventual timber harvesting operations.

2.1.3 Classification of Soil Stability

Soil stability is related to the internal cohesive properties of a surface deposit which enable it to resist deformation. The presence of certain chemical or mineralogical constituents will increase stability. Carbonates, for example, will undergo recrystallization which binds particles. Clay particles will also act as a binder, but less effectively. Sediments lacking carbonates or clays consequently will tend to lack stability. In addition, the distribution of particle sizes will affect stability. Unsorted deposits with intimately-mixed particles ranging from boulder to clay size (e.g., tills) are more stable than well-sorted deposits with a narrow range in particle size (e.g., aeolian sands). Finally the bedrock formation underlying shallow deposits will differ in holding ability. Most bedrock on the area is sandstone or shale lacking cementing carbonates, but the Wapiti Formation, occupying portions of the Upper Kakwa and Smoky drainages, is a carbonate-cemented sandstone favoring the stability of shallows soils.

A soil stability series was prepared for the deposits identified. The five broad stability classes, with estimated percentage of the project area covered by each, are:

TABLE 2.1 CLASSIFICATION AND DESCRIPTION OF SURFICIAL DEPOSITS

Age	Deposit Identification No. (Vol. 2)	Deposit Name	Description	Stability Code	Estimated Percentage of Project Area
Mesozoic to Cenozoic	1	Bedrock	Nonforested alpine.	N/A	1
	2	Thin Colluvium on Bedrock	Associated with steep upper slopes, largely on SW fringe of area, close to tree line. Thin, unstable deposits of dislodged or weathered bedrock.	4	15
Pleistocene and Recent	3	Old Cordilleran Till	Generally thin (5-10 ft) and deeply weathered due to age. Unsorted carbonate rich gravel, sand, silt, and clay.	2	1
Pleistocene and Recent	4	Continental Till, quartzite-rich	Till overlying and derived from grinding of Tertiary gravels, which are quartzite-rich. Lack of carbonate cementation results in reduced stability.	3	10

TABLE 2.1 CLASSIFICATION AND DESCRIPTION OF SURFICIAL DEPOSITS - continued

Age	Deposit Identification No. (Vol. 2)	Name	Description	Stability Code	Estimated Percentage of Project Area
Pleistocene and Recent	5	Cordilleran and Mixed Tills	Rich in carbonates originating from Rocky Mountain limestones. This CO_3 content provides stability.	1	20
Pleistocene and Recent	6	Thick Continental Till	Sandy to clayey till derived from Canadian Shield rocks. Higher sand component in south, higher clay in north; usually not stony; stable.	1	16
Pleistocene and Recent	6A	Thin Continental Till	Southwest extremities of 6 above. Thinner, but still stable.	1	10
Pleistocene and Recent	7	Glaciofluvial (River) Deposits	Originating from action of ice-contact meltwater (partially sorted) and meltwater rivers (fully sorted). Heavy gravel and sand content, of value for road construction.	3	1

TABLE 2.1 CLASSIFICATION AND DESCRIPTION OF SURFICIAL DEPOSITS - continued

Age	Deposit Identification No. (Vol. 2)	Name	Description	Stability Code	Estimated Percentage of Project Area
Pleistocene and Recent	8	Glaciolacustrine (lake) Deposits	Originating from lakes impounded by retreating glaciers. Heavy clay and silt content, with sand near old deltas. Level or gentle topography.	2	15
Pleistocene and Recent	9	Aeolian (wind-borne) Deposits	Originating from lacustrine sands transported by wind, notably near Grande Prairie but also at Brule Lake. Well-sorted fine sand lacks clay or other binding material. Highly unstable.	4	2
Pleistocene and Recent	10	Alluvium	Originating from post-glacial river action. Deposits are generally thin (5-10 ft.) since rivers are still downcutting. Large or steep rivers deposit gravels; smaller or slower streams, gravel, sand, silt, or clay. Sorting produces deposits less stable than in till.	2	5

TABLE 2.1 CLASSIFICATION AND DESCRIPTION OF SURFICIAL DEPOSITS - continued

Age	Deposit		Description	Stability Code	Estimated Percentage of Project Area
	Identification No. (Vol. 2)	Name			
Pleistocene and Recent	11	Alluvial Fan Deposits	Minor in extent, at foot of mountain streams. Generally sloped, with poorly-sorted sediments from upstream. Generally inactive and recently vegetated.	2	Trace
Pleistocene and Recent	12	Slump	Active or recent gravitational movement. Common along Kakwa, Cutbank, Smoky and other rivers. Actively widening river valleys. Minor slumping is evident on steep upper slopes, but is presently inactive. Associated with shale bedrock and Deposit No. 2 above.	4	1
Pleistocene and Recent	13	Organic Deposits	Muskegs and sedge bogs. Perma-frost is common. Forest cover is generally unmerchantable or lacking.	N/A	3

Code	Description	Percent of Project Area
0	Unclassified Stability (Nonproductive Bedrock and organic)	4
1	Very stable	46
2	Moderately stable	21
3	Unstable	11
4	Very unstable	18
		100

Classes 0 and 1 are unshaded on the Soil Stability Overlay in Volume 2, while classes 2, 3 and 4 are given progressively darker shading with increasing instability. Stability classes are shown for each deposit in Table 2.1, together with estimated percentages by area.

2.1.4 Terrain Slope

For purposes of establishing sensitivity to disturbances, ground slope is an obvious further variable in addition to stability as defined above. Unstable deposits on level ground may be less sensitive to erosion than more stable deposits on steep ground. The Percent Slope Overlay in Volume 2 shows the distribution of terrain of varying steepness, and in conjunction with the Soil Stability Overlay, permits observation of the combined effect of both.

The Percent Slope Overlay was prepared by adaptation of existing Soil Survey of Alberta maps, with supplemental use of 1:50,000 and 1:63,360 contour maps for uncovered portions of the area.

The five Slope Classes recognized, with the estimated percentage of the area covered by each, are:

Code	Description	Percent of Project Area
0	Unclassified slope (generally steep but nonproductive)	4
1	0 to 15 percent slope	78
2	16 to 30 percent slope	14
3	31 to 45 percent slope	3
4	Over 45 percent slope	1
		100

2.1.5 Erosion Sensitivity

The combined effect of material stability and slope can be observed by superimposition of the resulting Percent Slope and Soil Stability map overlays upon each other and upon the base map. Dark shadings outline combinations of steepness and instability which imply relatively high sensitivity to harvesting erosion. By the arithmetic addition of the respective codes, a series of Erosion Sensitivity classes ranging from two to eight (on productive land) can be created.

A compilation of land areas for each Erosion Sensitivity code, subdivided by tenure, is shown in Table 2.2. Code 8 (highly unstable material on slopes over 45 percent) occurs on only 0.9 percent of the project area, and is of questionable operability. Code 7 (combinations close to maximum instability and slope) occurs on an additional 2.0 percent. Code 6 (marginally unsafe operating conditions) occurs on an added 6.8 percent. Variations in this general pattern can be noted for the individual tenures.

Recommendations for modification of timber harvesting practices on these areas of high sensitivity are made and discussed in the following chapters.

2.2 Soils

2.2.1 Parent Materials

As outlined in the preceding section, the surficial materials on which the soils are formed include glacial tills, glaciofluvial deposits, lacustrine sediments, colluvium, alluvium, aeolian deposits, and weathered bedrock. Over much of the project area, these materials are calcareous. The texture (particle size distribution) and calcium carbonate ($CaCO_3$) content of these materials, together with drainage conditions, are among the most important variables influencing soil formation, soil fertility, forest productivity, and soil management problems within the project area.

2.2.2 Published Soil Surveys

Much of the project area is covered by the

TABLE 2.2

COMBINED SENSITIVITY TO EROSION BASED ON SURFICIAL DEPOSIT AND GROUND SLOPE

		TENURE *									
Stability/ Slope	Combined Sensitivity Code	P G		NCFI		NWPP		CROWN		TOTAL	
		Sq.Mi.	%	Sq.Mi.	%	Sq.Mi.	%	Sq.Mi.	%	Sq.Mi.	%
0 + 0	0 (Non-forest)	226	4.8	1	0.1	267	8.7	411	8.7	905	6.8
1 + 1	2 (Stable, Level)	1,310	27.7	399	46.1	1,249	40.6	1,456	30.8	4,414	33.0
1 + 2 2 + 1	3	1,532	32.4	323	37.3	691	22.5	1,158	24.6	3,704	27.7
1 + 3 2 + 2 3 + 1	4	332	7.0	75	8.7	480	15.6	623	13.2	1,510	11.3
1 + 4 2 + 3 Etc.	5	718	15.2	48	5.6	234	7.6	544	11.5	1,544	11.5
2 + 4 3 + 3 4 + 2	6 (Sensitive)	410	8.7	18	2.0	130	4.2	361	7.7	919	6.8
3 + 4 4 + 3	7 (Highly Sensitive)	122	2.6	2	0.2	23	0.7	119	2.5	266	2.0
4 + 4	8 (Unstable, Steep)	78	1.6	tr.	tr.	4	0.1	47	1.0	129	0.9
TOTAL		4,728	100.0	866	100.0	3,078	100.0	4,719	100.0	13,391	100.0

*PG - Procter & Gamble Forest Management Agreeement Area
NCFI - North Canadian Forest Industries Management Agreement Area
NWPP - North Western Pulp and Power Management Agreement Area
CROWN - Remainder of project area

"Exploratory Soil Survey of Alberta: Map Sheets 85-L, 83-K, 83-F, and 83-J" (Lindsay, Wynnyk, and Odynsky, 1963). This is a reconnaissance survey, classifying soils at several mapped points according to Soil Order or Great Group, parent material, and profile development. Maps in the report are printed at a scale of approximately 1:800,000 and no soil boundaries are indicated. Chemical analyses are given for three profiles and pH data for less than a dozen profiles in the mapped area of about 22,400 square miles. No interpretations for management are included.

More detailed surveys at the periphery of the project area include those of the Beaverlodge and Blueberry Mountain sheets (Odynsky et al., 1961) and the Grande Prairie and Sturgeon Lake sheets (Odynsky et al., 1956). Several profile description in the latter surveys are applicable to soils within the project area. These surveys lack specific reference to forest land management, but they have interpretive value.

Soils of the Hinton area (83-F, W-1/2) and of the Edson area (83-F, E-1/2) have recently been mapped at 1:126,720 (1 inch to 2 miles) but the soil survey report to accompany these maps has not yet been published.

In short, soils information for much of the area is cursory, mapped at small scale, and lacking in detail of significance to managers of forest lands. Discussions of soil problems which follow are thus based largely on field observations.

2.2.3 Soil Orders

The significant soil orders identified on the area, in descending order of extent, are:

1. Luvisols (calcareous C horizon, clay accumulation in B). These are by far the most abundant soils of the project area.

   Luvisolic soils occur on most parent materials in the project area, particularly on the calcareous materials, except under conditions of poor drainage where they grade into Gleysolic and Organic soils. Luvisolic soils are characterized by clay accumulation in the B horizon, which influences root penetration, drainage, and engineering.

2. Gleysols (mottled, unoxidized B horizon caused by poor drainage).

   Gleysolic soils are mineral soils developed under conditions of poor drainage which may be due to soil texture, soil structure, and (or) topographic position. Because they are characterized by reducing conditions, certain elements such as iron and manganese tend to be highly available to plants growing in such soils. The poor drainage conditions characteristic of Gleysols make some of them subject to windthrow problems, particularly along cutting boundaries.

   This can be a compelling argument for limiting or extending clear-cut size on a site-specific basis.

3. Organic Soils (surface conditions prevent breakdown of vegetation).

   Organic soils generally have organic matter accumulation over 40 to 60 cm in depth (the classification criteria are complex). Such soils are (for timber cropping) among the least productive in the project area.

4. Brunisols (brownish, weakly developed B horizon, on exposed sites).

   Brunisolic soils occur where factors of soil formation have produced a weakly developed B horizon which does not qualify for classification in other soil orders.

5. Regosols (lacking in horizon development).

   Regosolic soils are generally confined to very recent deposits, e.g., fresh alluvium.

6. Podzols (upland soils on non-calcareous strata).

   Podzolic soils are most common on sandy, non-calcareous well-drained materials. These soils, characterized by iron accumulation in the B horizon (Humo-Ferric Podzols), are not widely distributed in the project area. However, the podzolization process is evident in some of the Luvisolic soils (Bisequa Gray Luvisols, principally).

Forest Management problems associated with several of these soils are described in Chapter III.

2.2.4 Forest Productivity

Together with climate and topography, soil conditions dictate that forestry, not agriculture, will remain the primary surface use of lands within the project area. Forest productivity has been the subject of Canada Land Inventory (CLI) investigations in recent years. Data from several Alberta Forest Service permanent sample plots located in the project area were used in these investigations. Progress in land capability analysis for forestry in Map Sheets 83-K and 83-L (and elsewhere) was reviewed a few years ago by Prokopchuk in the report by Knight (1967).

For the area just south of the project area, on the east slope, Duffy and Nemeth (1969) summarized their forest capability interpretations as follows:

> "Lodgepole pine was taken as the main indicator species. The best pine growth (Capability Class 3, mean annual increment 71-90 cubic feet per acre)[1] is associated with deep, moderately well-drained till sites below the elevation of 4,500 feet. Above this elevation, the site is associated with Capability Class 4 (M.A.I. 51-70 cubic feet). Less productive land is found in a wide range of surficial materials (alluvium, colluvium, till/bedrock, till and alluvial lacustrine) on well-drained to imperfectly drained conditions. As the soil moisture conditions become more extreme (rapidly drained, well drained, poorly drained and very poorly drained) and on porous aeolian soils, capability rating drops to 5 (M.A.I. 31-50 cubic feet) and 6 (M.A.I. 11-30 cubic feet). Some muskeg and rocky alpine sites are rated Class 7 (M.A.I. less than 10 cubic feet). The main limiting factors appear to be drought (low rainfall), exposure to sun and drying winds on south and west-facing slopes, soil moisture deficiency and excess, and restriction of the rooting zone by bedrock."

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[1] CLI forest capability ratings refer to yields theoretically attainable under intensive management. With only local and fortuitous exceptions, current yield per acre is far short of theoretical yield.

For the Marsh Head Demonstration Area, near the project area boundary west of Whitecourt, Knight and Duffy (1967) concluded:

> "... the best forest growth (M.A.I. 91-110 cubic feet per acre per year; Capability Class 2) is associated with moderately well-drained, sandy clay loam till sites on upper north-facing slopes. Some of these sites have a thin overlay of water-deposited sandy loam. Less productive land is found on moderately well-drained till soils on upper and middle portions of south-facing slopes and on imperfectly drained hill-tops (M.A.I. 71-90 cubic feet; Capability Class 3). As the soil drainage conditions and local climate become less favorable the M.A.I. drops to 51-70 cubic feet (Capability Class 4). The sand dune-muskeg complex in the lowlands is rated as Class 5 (M.A.I. 31-50 cubic feet). Dry sand dunes and poorly drained muskeg sites are rated as Class 6 (M.A.I. 11-30 cubic feet). Class 7 is confined to very poorly drained muskeg (M.A.I. less than 10 cubic feet)."

In the area north of Edson, soils of the Mayberne association may attain Class 1 (M.A.I. 111-130 cubic feet per acre per year), and a few sites are even more productive. Within the area of the Edson Map Sheet 83-F, muskeg productivity is generally rated as low Class 5, and occasionally Class 6 (information from Forest Productivity Rating Maps for Soil Survey Report No. 32).

2.2.5 Organic Matter Accumulation

On most of the project area forest floors over mineral soil are not excessively thick, permitting conventional scarification where organic matter must be removed to improve soil physical conditions for forest regeneration.

Reduction of soil organic matter (including forest floor material) often follows cutting or burning because the thermal regime tends to become more favorable for decomposition. Nevertheless exceptions to this generalization are common where poor drainage inhibits decomposition or where disturbances have been widely separated over the centuries.

In certain Gleysolic soils (e.g., some soils of the Erith association, north of Hinton) organic accumulation may range up to 60 cm in depth, posing difficult site preparation problems. Removal of thick organic layers by blading is not always wholly satisfactory in terms of inherent soil physical properties, physical deterioration of mineral soil during treatment, regeneration success, and erosion potential.

2.2.6 Soil Fertility

Soil fertility does not appear to be an important variable accounting for large differences in forest productivity over most of the project area, though there are some local exceptions. Fertilizer trials are reported to have shown no substantial positive growth response to addition of any nutrient element. However, the scope of forest soil fertility work within the project area has been limited, and further work may define some significant tree nutrition problems. At present, physical limitations on tree growth appear more significant than chemical limitations.

It is not unlikely that potential nitrogen deficiencies occur in the project area, as in many similar boreal forest areas of the world. Though these are not particularly apparent at present, they might become evident as management ameliorates other limitations on forest productivity. However, the present harvesting of old growth stands, providing generally improved microclimatic conditions for organic matter decomposition, may result in gradual conversion of substantial stores of organic nitrogen to mineral forms which may be taken up by plants. This may somewhat reduce or defer the need for more deliberate soil nitrogen management.

Soil acidity over most of the project area tends to be nearly optimum for balanced availability of micronutrient elements. However, because much of the area is occupied by parent materials high in $CaCO_3$, deep scarification of forest soils may locally result in high surface soil pH and a consequent syndrome of micronutrient problems (and perhaps other related problems).

The severity of these problems may vary with tree species, and it may eventually be ameliorated by acid leaching under re-established tree cover. High $CaCO_3$ in undisturbed surface soils is encountered locally, e.g., in the vicinity of Hinton, but the extent of this is limited. In the Hinton area, productivity of the high-lime soils is often in Capability Class 5 (31-50 cubic feet per acre per year), but occasionally higher.

2.3 Climate

The project area lies within the cool temperate zone, as classified by Keoppen, et al. For the most part, the region has cold winters and short cool summers. The Rocky Mountains have a pronounced effect on the climate of this region. The mountain passes and valleys extending east from the continental divide provide channels for air flow from British Columbia.

The Brule-Athabasca corridor and the Jackpine River-Smoky River Valley are two examples. North of Jasper National Park, the Rockies in British Columbia decrease in elevation and become more dispersed, thus offering less resistance to the flow of Pacific air into the Peace River region.

In addition to the "orographic effect" (which creates a rain and snow shadow along some parts of the east slopes), the mountains influence early summer air mass movements and convective activity from daytime heating, producing local variations in the regional climatic picture.

Records from a few permanently-occupied stations (usually located in valleys) and from a larger number of summer-occupied Lookout (L.O.) stations are the source of much of the localized climatic information which follows. Lookouts, because of their exposed locations and seasonal occupation, may provide imperfect data for some purposes. Figure 2.2 is a map showing the locations of the stations at which meteorological data are recorded, together with an identifying list.

June, July, and August are the peak rainfall months. Rainfall tends to peak in June and July in the southern part of the project area, and in August in the northern part of the region. This shift tends to coincide with north/south movements of lows which are associated with the jet stream. This movement reaches a northerly limit of about 55° latitude in August, followed by a southerly displacement (Klein, 1957).

Seasonal high temperatures occur in July, with a few exceptions. The month of January is usually the coldest month.

Variations in thermal, moisture and radiational characteristics occur over short distances and create local effects typical of mountain regions. However, identification of these effects is beyond the scope of this study.

Figure 2.2

IDENTIFICATION AND LOCATION OF STATIONS

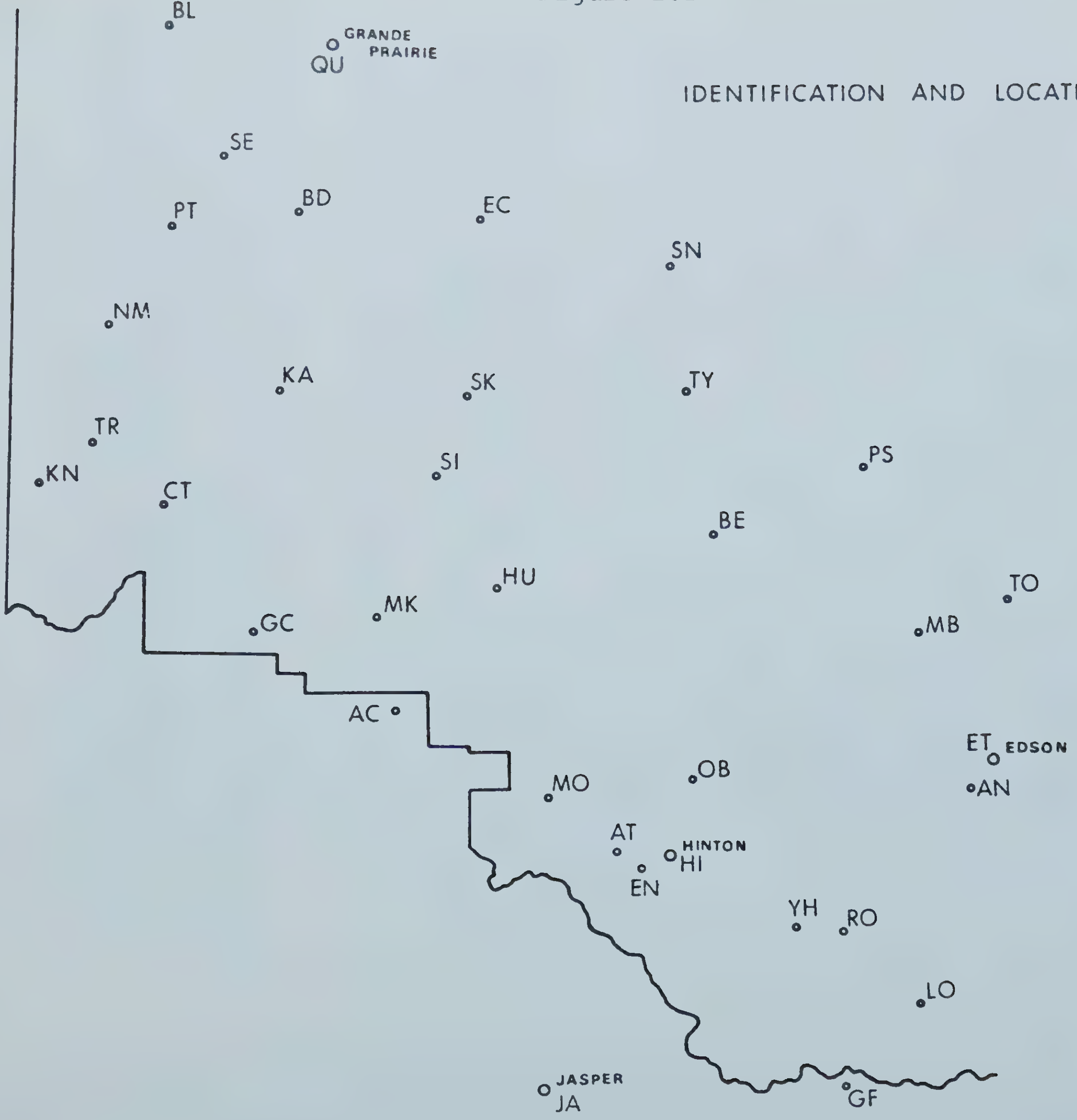

BL
GRANDE PRAIRIE
QU
SE
PT
BD
EC
SN
NM
KA
SK
TY
TR
PS
KN
SI
CT
BE
HU
TO
MK
GC
MB
AC
ET
EDSON
OB
MO
AN
AT
HINTON
HI
EN
YH
RO
LO
JASPER
JA
GF

Figure 2.2
- continued

INDEX OF STATIONS

Stations	Identification
Adams Creek LO (Lookout)	AC
Ansell LO	AN
Athabasca LO	AT
Bald Mtn. LO	BD
Beaverlodge	BL
Berland LO	BE
Copton LO	CT
Economy LO	EC
Edson A	ET
Entrance	EN
Grande Cache RS (Ranger Station)	GC
Grande Prairie A	QU
Grave Flats LO	GF
Hinton	HI
Huckleberry LO	HU
Jasper	JA
Kakwa LO	KA
Kakwa Notus	KN
Lovett LO	LO
Mayberne LO	MB
Moberly LO	MB
Muskeg RS	MK
Nose Mtn. LO	NM
Obed LO	OB
Pass Creek LO	PS
Pinto LO	PT
Robb RS	RO
Simonette LO	SI
Smoky LO	SK
Snuff Mtn. LO	SN
South Wapiti RS	SE
Tom Hill LO	TO
Tony LO	TY
Torrens LO	TR
Yellowhead LO	YH

SCHULCO

2.3.1 Temperature

Mean annual temperatures range from 31.2° F at Muskeg Ranger Station to 38.1° F at Entrance. July is generally the warmest month with mean temperatures mostly in the mid to high fifties. Mean July temperatures exceeding 60° F do not occur very frequently.

The effect of elevation on mean growing season temperatures is not great in absolute terms, but probably contributes significantly to elevational differences in conifer survival and growth. This relationship is apparently more consistent in northern portions of the area than to the south, but generally mean summer temperatures decrease by approximately 2° F per thousand feet increase in elevation of the recording station.

There is evidence that year-to-year variations in temperature during the growing season are no less important than place-to-place variations, particularly at critical stages in the regeneration of conifers. Mean, maximum and minimum temperatures for a given location and month vary considerably from year to year. Standard deviations of these values calculated for two Lookout sites, typical of forest ridges, are:

Standard Deviations of Monthly Temperatures in °F

	Mean Temperature					Maximum Temperature					Minimum Temperatur				
	M	J	J	A	S	M	J	J	A	S	M	J	J	A	S
Bald Mountain Lookout	7.6	5.2	5.1	5.1	6.7	10.0	7.3	7.3	7.3	8.9	6.8	5.3	4.7	5.1	6.8
Yellowhead Lookout	7.1	5.2	5.7	5.4	6.5	10.6	7.9	7.9	8.2	9.7	6.2	5.2	5.7	5.0	6.2

These data suggest that in a given year growing season temperatures may vary from the general average by as much as 5° F every third year (1 standard deviation), and by 10° F every twentieth year (2 standard deviations). The occurrence of climatically "bad" years may explain failures in restocking which would not take place in an "average" year.

Winter temperatures below -40° F are not uncommon throughout most of the area. Winter temperatures at Jasper are significantly higher than those at Edson because of the influence of modified Pacific air masses. Winter temperatures in some of the interior valleys along the mountains are probably more moderate than elsewhere in the area, and this fact may influence the winter use patterns of wildlife.

2.3.2 Relative Humidity

Relative humidity measurements are taken twice daily at a number of seasonally-occupied forestry lookout stations for use in calculating the Fire Weather Index.

The following year-round mean relative humidity figures (percent) are from Ministry of Transport records, based on observations taken four times a day (1957-1966).

	J	F	M	A	M	J	J	A	S	O	N	D
Grande Prairie	80	79	77	64	53	58	63	65	69	69	81	83
Edson	76	77	72	58	57	61	67	70	71	66	77	81
Whitecourt	74	75	67	55	55	63	67	72	73	66	77	81

All available data indicate generally drying conditions in May which contribute to fire hazard, followed by more humid conditions throughout the growing season (June, July and August). As with temperatures, however, averages compiled over lengthy periods mask the occurrence of drought periods in individual years.

2.3.3 Frost-free Period

The frost-free period throughout the project area is not long. The range for those stations where frost observations were recorded is from about 50 days to 120 days. Some stations near the tree line have occasional frost during every month of the year.

MacIver (1970) calculated some examples of the killing frost-free period, defined as the number of days between the last spring occurrence of minimum temperatures below 28° F and the first fall occurrence of minimum temperatures of 28° F. His range of killing frost-free days was from 112 to 151.

The potential for active growth is measured in growing degree-days (sum of daily temperatures exceeding 42° F).

The table below lists the monthly and seasonal averages for a number of stations, arranged in descending order of growth potential:

Degree-days above 42° F (after MacIver)

STATION	M	J	J	A	S	TOTAL	Maximum Growing Days (Total/42°)
Grande Prairie	247	430	581	522	252	2032	48
Economy Lookout	225	383	528	471	240	1847	44
Bald Mountain Lookout	209	384	534	475	221	1823	43
Edson	180	371	541	483	229	1804	43
Snuff Mountain Lookout	206	365	501	452	217	1741	41
Hinton	181	353	506	448	217	1705	41
Entrance	165	330	481	429	193	1598	38
Kakwa Lookout	151	297	451	396	172	1467	35
Simonette Lookout	135	275	428	372	157	1367	32
Yellowhead Lookout	128	272	423	365	165	1353	32

Maximum time for active growth, by this arbitrary measure, thus averages only from 32 to 48 days each year.

2.3.4 Evapotranspiration

Trees are major consumers of water. Transpiration studies in lodgepole pine forests of the Western United States show that 8 to 10 inches of water are consumed annually. Similar results were obtained in a study done at the Kananaskis Forest Experiment Station.

MacIver (1970) derived evapotranspiration estimates using various parameters for a number of stations within the project area, and the average for all stations is as follows:

Evapotranspiration (Actual) in inches

M	J	J	A	S	Season
2.7	3.7	3.9	3.1	1.8	15.2

These estimates suggest rather high losses in relation to total annual precipitation.

2.3.5 Photoperiod and Daily Bright Sunshine

With relatively small variations due to differences in latitude, mean day-length values for the entire project area (after MacIver) are as follows:

	M	J	J	A	S
Day-length (hours)	15.8	16.9	16.4	14.6	12.5

Of daylight hours, those for which bright sunshine is recorded at Beaverlodge (30 years of record) and Edson (10 years of data) are:

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
Beaverlodge	75	106	162	214	270	276	300	259	176	139	83	62	2122
Edson	85	115	152	190	234	246	271	248	162	150	79	68	2000

Both the Beaverlodge and Edson areas receive more hours of sunshine than most of the project area. Greater cloud cover over most of the project area during June and July results in about 30 hours less sunshine per month than Grande Prairie. These data and observations suggest rapid daily growth during the short growing season, but also conditions for lethal ground temperatures and rapid desiccation of germinates or slash.

2.3.6 Precipitation

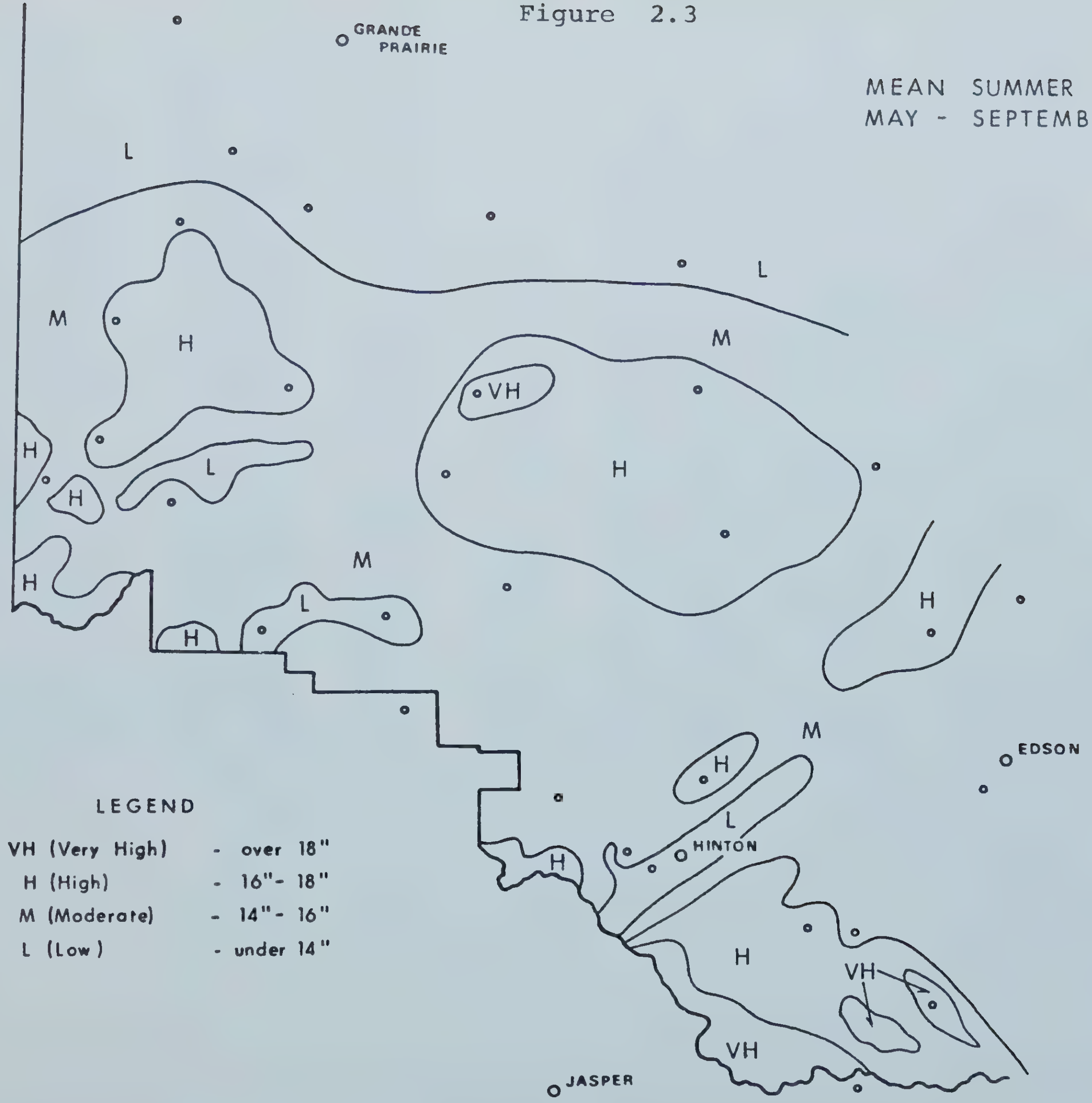
Total annual precipitation averages from 15 to 25 inches within the project area. (See Appendix II.1.)

Summer precipitation (May to September) over most of the project area accounts for about 63 percent of the annual precipitation, but amongst the high mountains to the west this proportion of summer to annual precipitation may drop to 50 percent.

Summer precipitation ranges from about 13 inches (Muskeg Ranger Station) to 18 inches (Smoky Lookout) over the project area. Figure 2.3 is a precipitation zone map for the summer season. Rainfall appears generally to increase with increasing elevation and

Figure 2.3

MEAN SUMMER PRECIPITATION
MAY - SEPTEMBER


GRANDE PRAIRIE
EDSON
HINTON
JASPER
L
M
H
VH
LEGEND
VH (Very High) - over 18"
H (High) - 16"- 18"
M (Moderate) - 14"- 16"
L (Low) - under 14"

proximity to the Rocky Mountain summit, but many local contradictions to this trend occur.

June, July and August are the heavy rainfall months. July is generally the peak month for most stations but it is not uncommon for some northerly stations to receive the heaviest rainfall in August. The mean number of days with measurable precipitation is quite consistent throughout the entire area during the summer months, as follows:

June - 10 to 15 days with measurable precipitation
July - 10 to 15 days with measurable precipitation
August - 11 to 15 days with measurable precipitation

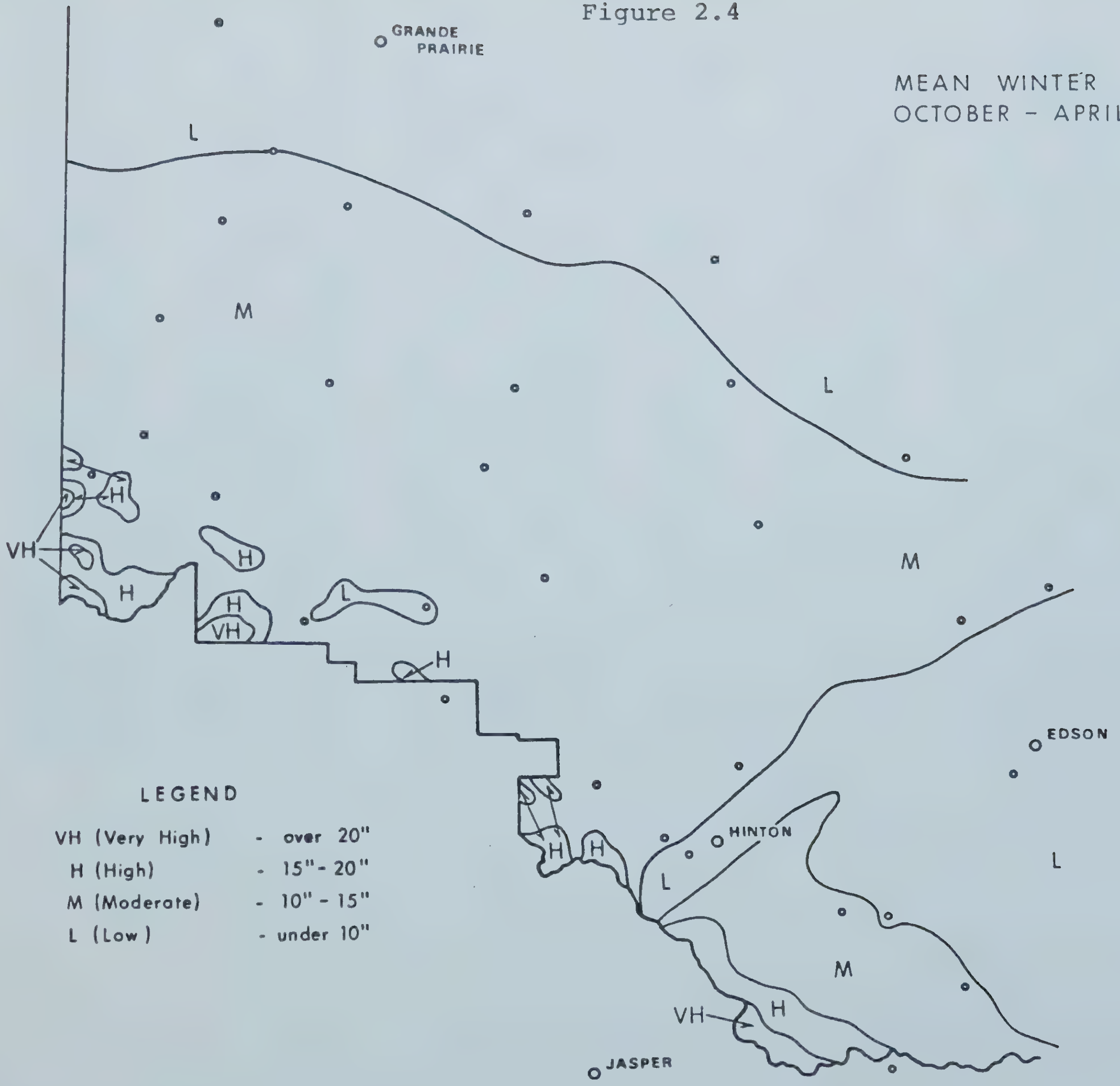
These wet days appear scattered through the summer. Protracted periods of summer drought do not thus occur in the "average" year.

Snowpack data are limited. Most of the records available are for the area south of the Athabasca River. (Water Survey of Canada, Snow Survey report covering about eight years). March 1 snow depths south of Hinton average about 15 inches at lower elevations (2700-3500 feet) and about 27 inches at intermediate elevations (3600-4500 feet). Snow data for the higher elevations are almost nonexistent.

Snowpack, like rainfall, varies with elevation, proximity to the mountains, and prevailing air mass movements. In many parts of the project area, snowfalls are common from September to May. Average duration of snowpack for much of the area is estimated at 160 to 180 days.

A generalized winter precipitation zone map (Figure 2.4) has been prepared from the limited data available. The zones north of Hinton were extended with less confidence than those to the south because of the lack of data

Figure 2.4


GRANDE PRAIRIE
EDSON
HINTON
JASPER
L
M
H
VH
LEGEND
VH (Very High) - over 20"
H (High) - 15"- 20"
M (Moderate) - 10" - 15"
L (Low) - under 10"

MEAN WINTER PRECIPITATION
OCTOBER - APRIL

between Hinton and Grande Prairie. Within this vast area, Muskeg Ranger Station is the only reporting station with a continuous record, (monthly record, Atmospheric Environment Service). Even without more detailed local data, it is clear that snowpack influences watershed and wildlife behaviour on the project area profoundly. Some of these influences are described in the following sections.

The annual precipitation zone map (Figure 2.5) is essentially a composite of the two previous maps. On these maps, particularly that showing summer precipitation, zones of high precipitation tend to coincide with areas supporting superior coniferous stands.

2.3.7 Storm Precipitation

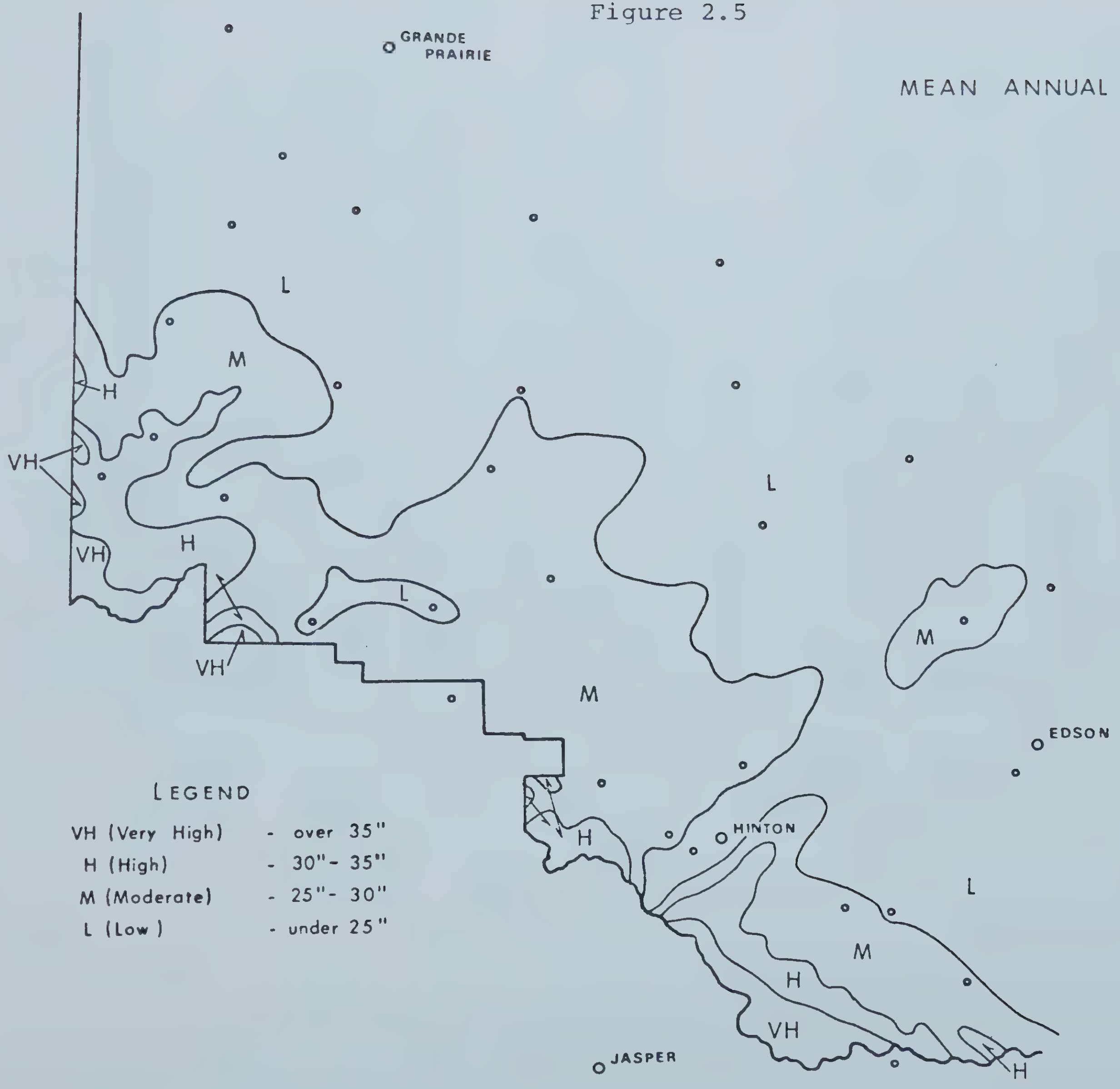
Figure 2.6 outlines areas of heavy rainfall activity, as derived from an analysis of major storm events from 1963 to 1972. The figures within each zone indicate the range of precipitation (inches) received from major storms.

A frequency analysis of maximum precipitation in 24 hours shows that during the period May to September about 75 percent of the heaviest 24-hour precipitation each month exceeds 0.5 inches, and 35 percent exceeds 1.0 inches. Precipitation of this order is highly significant in terms of erosion potential. Figure 2.7 is a graphical summary of the data from 17 stations for which this information is available.

Potential for major storm damage is indicated by records of maximum 24-hour precipitation ever recorded. Of 28 stations reporting,

Figure 2.5

MEAN ANNUAL PRECIPITATION


GRANDE PRAIRIE
EDSON
HINTON
JASPER
L
M
H
VH
LEGEND
VH (Very High) - over 35"
H (High) - 30"- 35"
M (Moderate) - 25"- 30"
L (Low) - under 25"

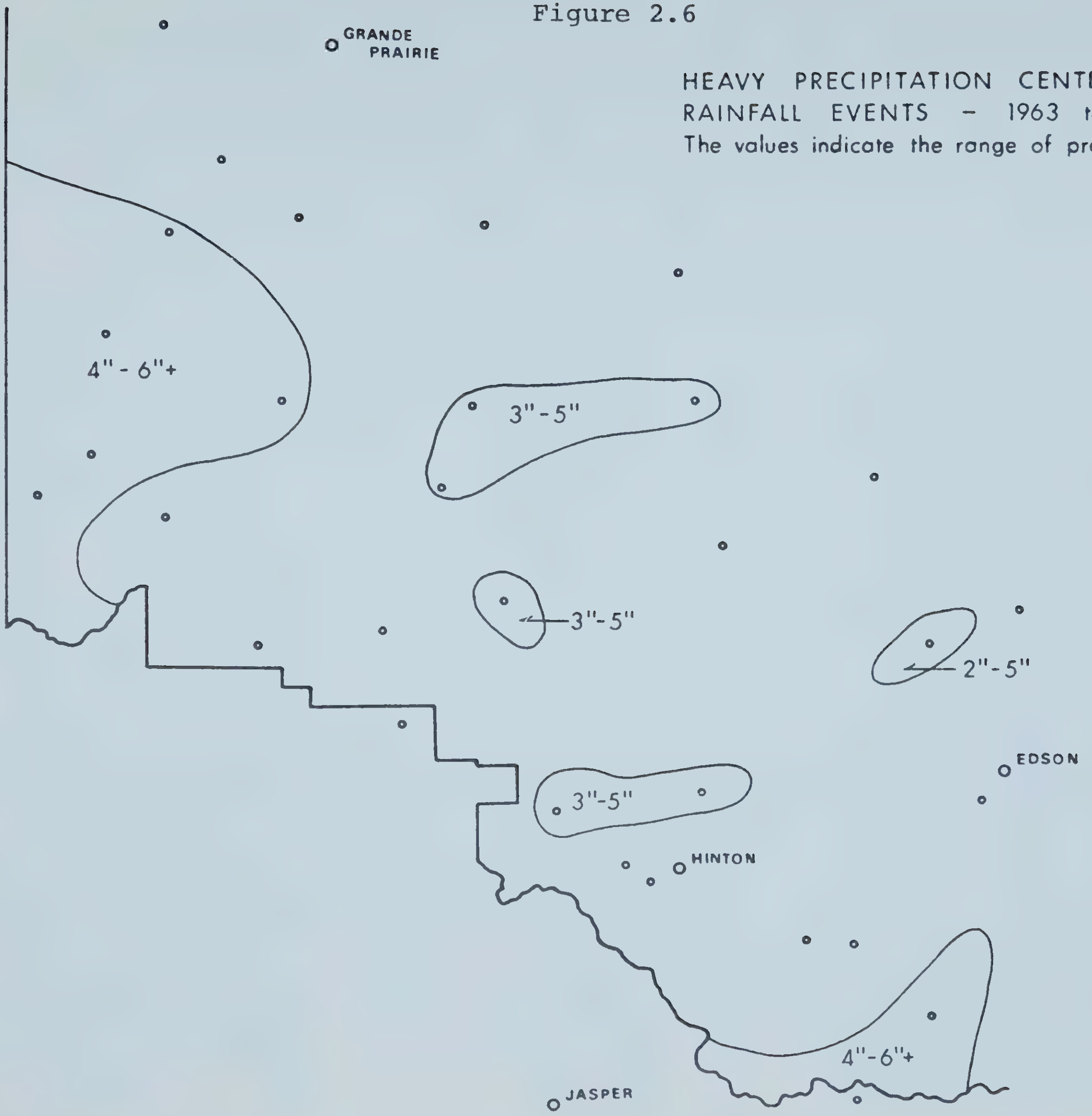

GRANDE PRAIRIE
4" - 6"+
3" - 5"
3"- 5"
2" - 5"
EDSON
3"-5"
HINTON
4"-6"+
JASPER

Figure 2.6

HEAVY PRECIPITATION CENTERS FROM MAJOR RAINFALL EVENTS - 1963 to 1972

The values indicate the range of precipitation received.

FREQUENCY OF MAXIMUM PRECIPITATION

IN 24 HOURS FROM MAY-SEPT FOR 17 STATIONS IN THE PROJECT AREA
(based on the heaviest fall in each month for the period of record)

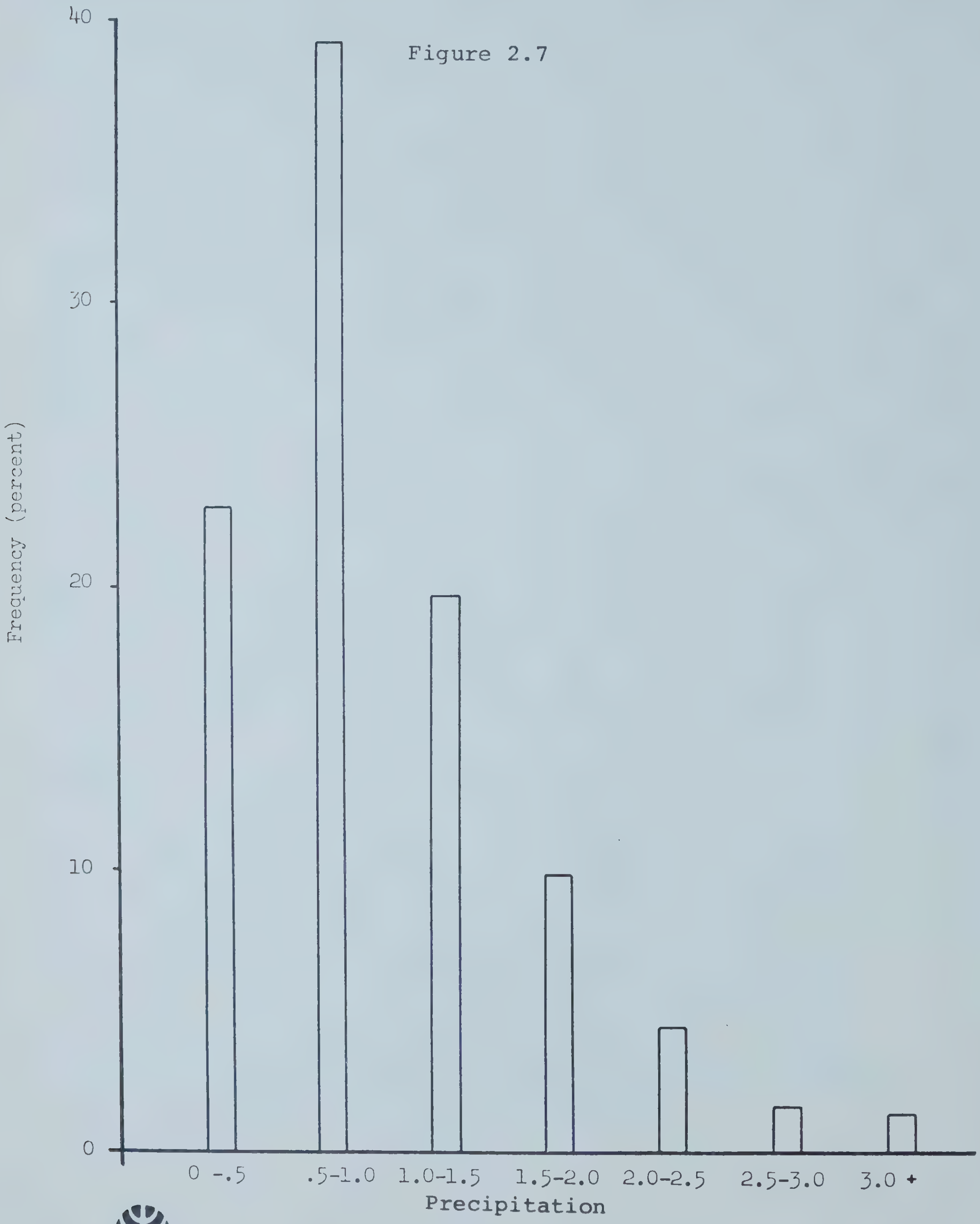


Figure 2.7

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9 stations are in the 2-3 inch category,

14 stations are in the 3-4 inch category, and

5 stations are in the 4-5 inch category.

These periods of heavy rainfall often occur in June, when run-off from snowmelt is already high.

During the June 1972 flood event, 6.08 inches of rainfall were recorded in 16 hours at a Foothills Resource Allocation Study site in the Cutbank watershed (Forest Land Use Branch data).

2.3.8 Lightning

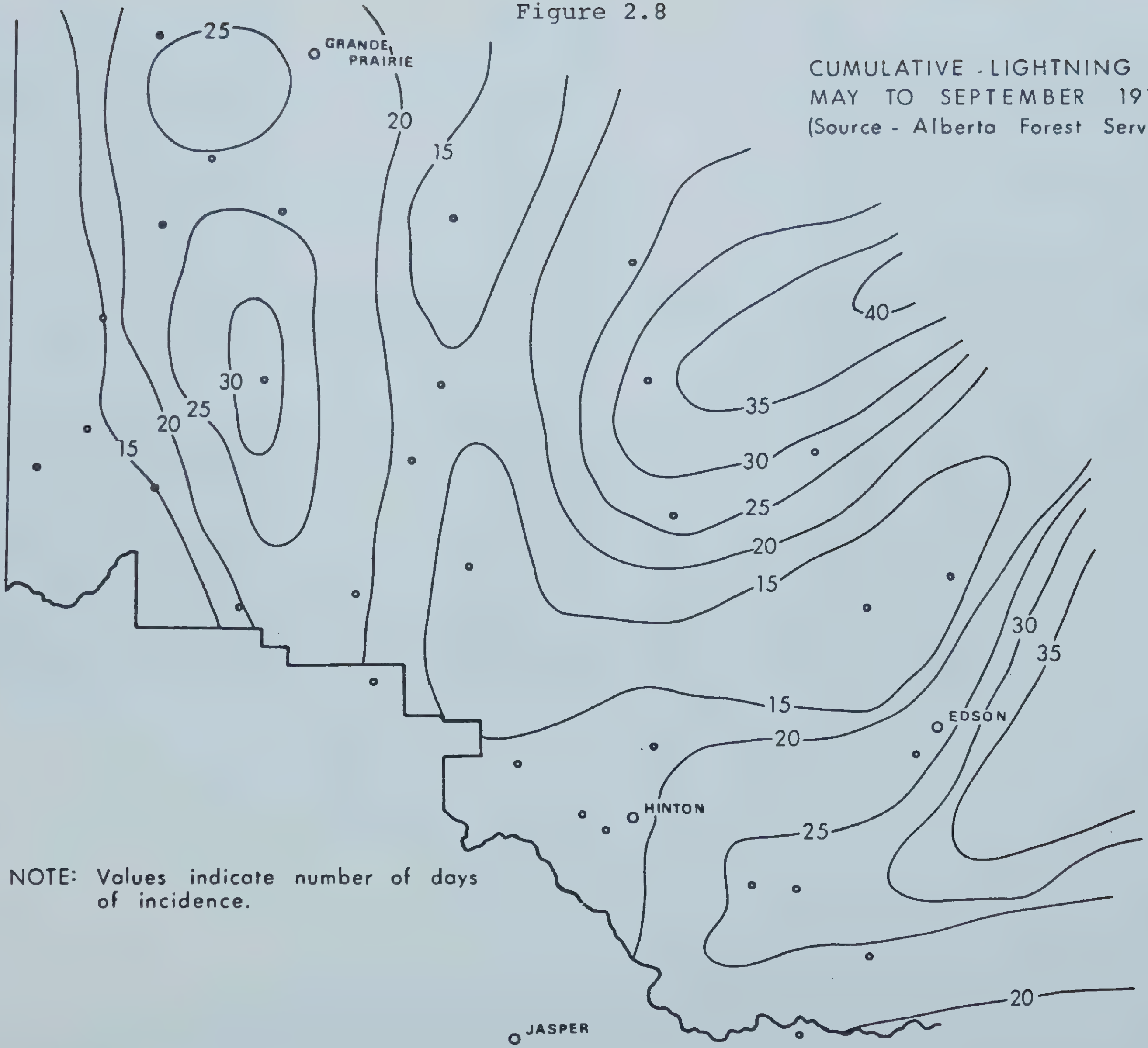
The entire project area is subject to summer lightning. Figure 2.8 is a map showing zones of lightning incidence. Centers of high incidence tend to lie well to the east of the centers of high summer precipitation shown in Figure 2.3.

2.3.9 Winds

Figure 2.9 shows the prevailing wind direction and average range of wind speed most frequently observed at forestry lookout towers during the summer. These data are based on daily observations taken at 1300 hours. The majority of stations record persistent but moderate winds. A few lookout stations, however, such as Bald Mountain, Kakwa, Copton, Adams Creek, Mayberne, and Grave Flats, have reported summer winds in excess of 50 m.p.h. The following table shows average wind speeds and maximum observed speeds for Grande Prairie and Edson.

Figure 2.8

CUMULATIVE LIGHTNING INCIDENCE
MAY TO SEPTEMBER 1972
(Source - Alberta Forest Service)


25
GRANDE PRAIRIE
20
15
30
25
20
15
40
35
30
25
20
15
30
35
15
EDSON
20
HINTON
25
20
JASPER

NOTE: Values indicate number of days of incidence.

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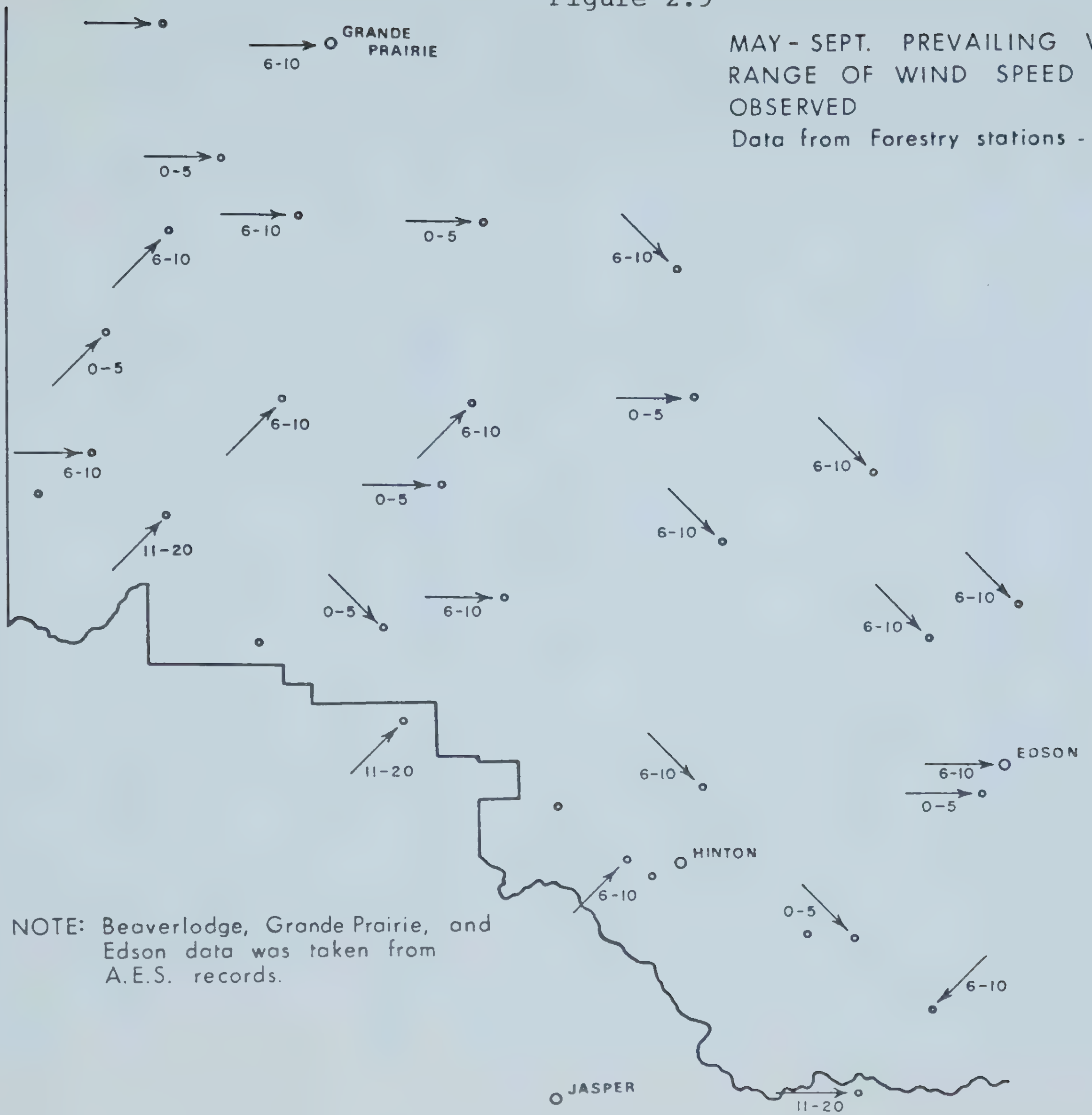
Figure 2.9

MAY - SEPT. PREVAILING WIND DIRECTION AND RANGE OF WIND SPEED MOST FREQUENTLY OBSERVED

Data from Forestry stations - observation at 1300 hrs.


GRANDE PRAIRIE
6-10
0-5
6-10
0-5
6-10
0-5
6-10
6-10
6-10
6-10
0-5
0-5
11-20
0-5
6-10
6-10
6-10
6-10
6-10
11-20
6-10
EDSON
6-10
0-5
HINTON
6-10
0-5
6-10
JASPER
11-20

NOTE: Beaverlodge, Grande Prairie, and Edson data was taken from A.E.S. records.

Grande Prairie - Period 1955-66

Average Wind Speed in m.p.h. (all directions)

J	F	M	A	M	J	J	A	S	O	N	D
7.6	8.6	8.9	10.2	11.2	10.7	9.3	9.5	9.4	9.9	8.4	7.8

Maximum Observed Hourly Speed - 58 from West
Maximum Observed Gust Speed - 68 m.p.h.

Edson - Period 1960-66

Average Wind Speed in m.p.h. (all directions)

J	F	M	A	M	J	J	A	S	O	N	D
5.6	6.1	6.9	7.1	7.1	7.0	6.1	5.9	6.2	5.8	5.4	5.3

Maximum Observed Hourly Speed - 60 from North-West
Maximum Observed Gust Speed - 74 m.p.h.

In mountain defiles such as Luscar, Entrance-Hinton, and Grande Cache, the average and gust wind speeds are likely to be higher than elsewhere because of the channeling effect.

These data and observations indicate that still air is not common in the area, and suggest:

- A potential for moderate windfall damage, particularly along exposed edges of mature stands.

- A potential for rapid drying of fuels and rapid spread of fires.

- A potential for rapid development of drought conditions affecting the establishment of conifer seedlings.

- A need for sheltered game habitat in winter.

"Chinook" conditions occur to a lesser extent than in southern Alberta. This combination of unseasonal warming and desiccating winds causes physiological drought (Red-belt) on exposed ridges.

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2.4 Hydrology

2.4.1 General Hydrologic Characteristics

The three major river systems (Wapiti, Smoky and Athabasca) draining the project area rise along the Continental Divide. The flow in the latter two is profoundly influenced by glaciers and snow fields. Especially in the Athabasca system glacial ablation is a significant part of the annual runoff. High flow levels in July and August are due to release of stored water from melting snow and ice, and are recorded for glacier-fed streams even when current rainfall is withheld.

The high-elevation drainages along the Rocky Mountains have higher water yields per acre than drainages tapping only the foothills. Most of the high-yield drainages are located outside of the project area. For example, Smoky River above Hell's Creek (near Grande Cache) has a mean annual runoff of about 27 inches, while the Waskahigan River near the community of Little Smoky has an annual yield of only 5.3 inches.

Further, there are definite differences in flow periodicity between streams rising in the mountains and those in the lower elevation areas to the east. May is usually the peak flow month for the eastern watersheds. However, for the watersheds draining the mountain region, June has the peak flow. Stream-flow responses from June rainfalls can be violent and rapid in the mountain watersheds, depending upon storm intensity and duration, vegetation, soils, and subsurface drainage. The Cutbank River, for example, had three major storm events in June 1972, totalling 6.8 inches of precipitation.

The measured discharge increased from 2.2 times to 8.5 times mean daily discharge in 24 hours. A rate of flow already close to maximum for the year was thus further quadrupled temporarily after each of these storms. It is believed that similar short-term responses to major rainfalls occur during most summers over some part of the project area.

2.4.2 Streamflow Regime

Stream gauging stations up until very recently have been restricted to the larger rivers which have drainage areas of 1,000 or more square miles. For example, two sites on the Athabasca and Wapiti Rivers have been maintained since before 1920, with major interruptions. All other recording stations were established since 1955, and many have operated for less than five years. There are highly significant fluctuations in yield from year to year depending upon the amount of snowpack and summer rainfall. The table below shows the extreme departures from mean annual flow for selected stations.

Station	Drainage area	Recorded Extremes of (Annual Flow/Mean Annual Flow) Percent
Wapiti (near Grande Prairie)	4,350 sq. mi	53% of normal to 153%
Smoky (at Watino)	18,500 sq. mi.	59% of normal to 148%
Little Smoky (near Guy)	4,130 sq. mi.	45% of normal to 188%
Athabasca (at Hinton)	4,000 sq. mi.	78% of normal to 117%
Athabasca (near Windfall)	6,990 sq. mi.	72% of normal to 138%
McLeod (above Embarras River)	1,010 sq. mi.	56% of normal to 176%

Mean monthly flows from year to year frequently have a still wider range of variation. Because of the magnitude of these fluctuations, changes in yield or timing due to forest harvesting or other disturbance are essentially non-detectable at major river stations. Stream gauging stations closer to forest harvesting areas and on smaller drainages would be required to correlate changes with harvesting.

The average percent of annual runoff in each month for the major gauging stations is shown in Table 2.3. The month of June in most cases has the greatest percentage of annual flow. However, as previously indicated, the Athabasca and Smoky Rivers remain at high levels in July and August because of glacial melt.

2.4.3 Water Yield Zones

The mean seasonal (May to September inclusive) and annual area inches of runoff are shown in Table 2.4. The delineation of the water yield zones (Figure 2.10) is based on the precipitation and streamflow data analyzed. In general, the zone boundaries follow major topographic changes. However, where there was sufficient information, the zone boundaries were adjusted accordingly. Many of the stream-flow records are for open water periods only, and estimates of winter-flows were made by extrapolation. The majority of the project area has less than 10 area inches of annual runoff.

A precise calculation of total or recoverable water yield is not possible. However, if only 2 inches per year of the above 10 inches of runoff were usable and recoverable on a regular basis, the 20,000 square mile catchment area drained by the major rivers leaving the project area would yield approximately 420 billion gallons annually. Urban consumption of water for combined domestic, industrial and institutional use is commonly estimated at 125 gallons daily per capita, or 45,625 gallons per year. These estimates suggest that the runoff leaving this area alone could supply urban populations totaling over 9 million. The nature of future allocations of

Table 2.3

AVERAGE PERCENTAGE OF ANNUAL RUNOFF IN EACH MONTH

E = Estimate

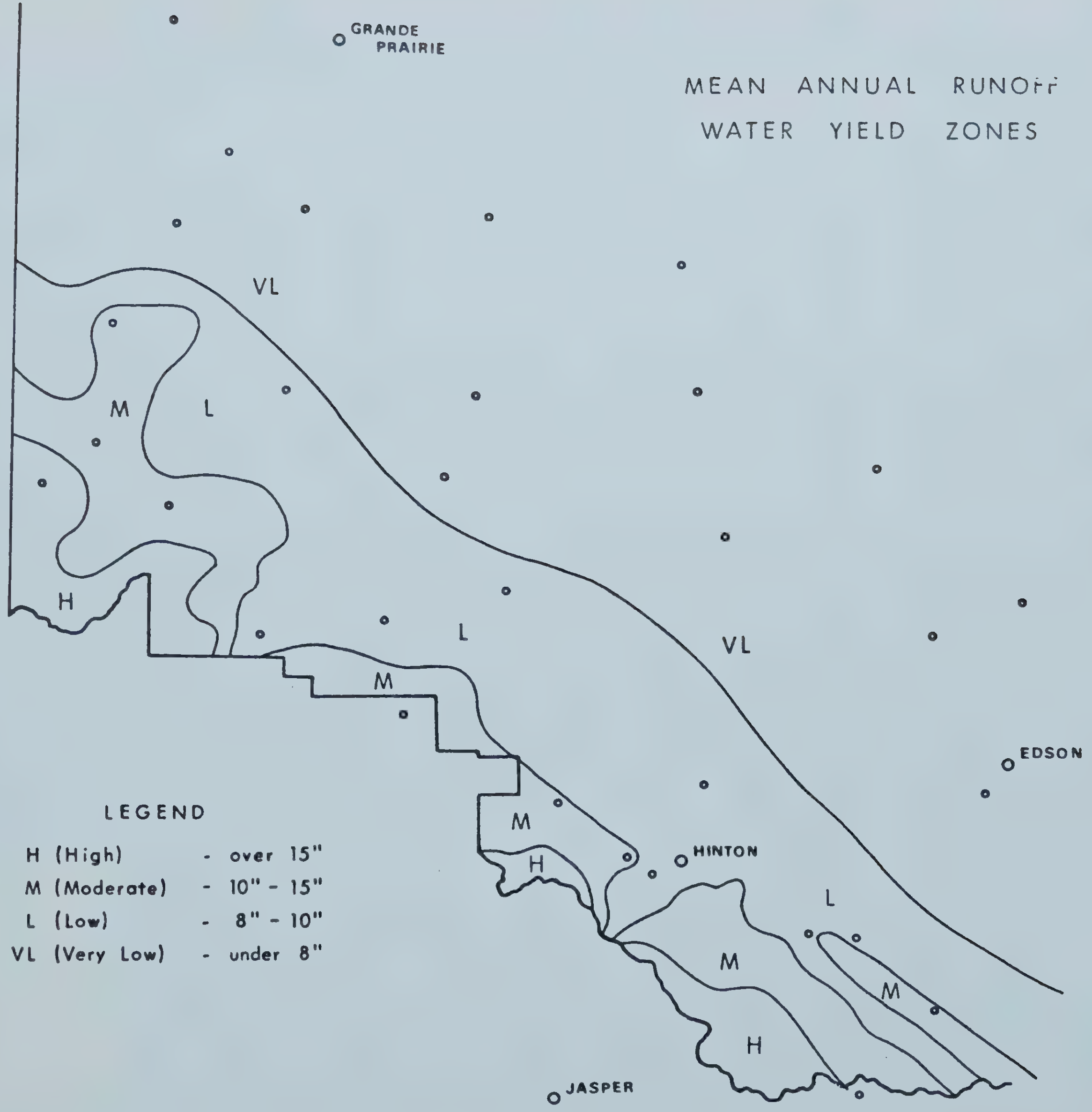
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wapiti nr. Grande Prairie	1	1	1	7	22	27	16	7	6	8	3	1	100
Smoky at Watino	1	1	1	8	21	25	17	10	6	5	3	2	100
Smoky above Hells Cr.	1	1	1	2	11	30	20	15	8	6	3	2	100
Cutbank R.	1^E	1^E	1^E	3^E	18	33	17	4	4	10	5^E	3^E	100
Muskeg nr. G. Cache	1	1	1	2	21	41	10	5	5	7	4	2	100
Wildhay R.	1^E	1^E	2	3	13	28	21	14	8	6	2^E	1^E	100
Simonette nr. Goodwin	1	.5	1	14.5	21	25	18	4	4	7	2	2	100
Little Smoky nr. Guy	1	1	1	19	25	16	14	10	6	4	2	1	100
Little Smoky at L.O.	1^E	1^E	2	12	23	20	16	9	5	6	3^E	2^E	100
Waskahigan R.	1	.5	.5	18	22	20	17	6	4	5	4	2	100
Athabasca nr. Windfall	2	2	1	3	10	24	22	16	9	6	3	2	100
Athabasca at Hinton	1	1	1	2	8	26	23	17	10	6	3	2	100
Athabasca at Jasper	1	1	1	2	8	23	25	20	10	5	2	2	100
Snake Indian R.	1^E	$.5^E$	$.5^E$	1^E	12	42	21	11	6	3^E	1^E	1^E	100
McLeod above Embarras	1	1	2	6	19	25	17	10	8	6	3	2	100
Wampus Cr. nr. Hinton	1^E	1^E	1^E	3^E	24	28	16	11	6	5	3^E	1^E	100

Table 2.4

AREA INCHES OF RUNOFF

Gauging Station	Seasonal (May 1 to Sept 30) 1972	Seasonal (May 1 to Sept 30) Long-term	Annual 1972	Annual Long-term
Athabasca at Hinton (1961-72)	19.9"	18.0"	23.4"	21.7"
Athabasca near Jasper (1913-31,1970-72)	27.9"	25.6"	31.4"	29.4"
Athabasca near Windfall (1960-72)	15.5"	14.3"	19.2"	17.8"
Beaverlodge near Beaverlodge (1968-72)	2.0"	1.6"	-	-
Cardinal near the mouth (1962-65,1969-72)	-	10.2"	-	12.6"^{E}
Cutbank near Grande Prairie (1970-72)	9.6"	7.6"	-	10.0"^{E}
Little Smoky near Guy (1960-72)	5.0"	4.4"	7.1"	6.0"
Little Smoky at Little Smoky (1967-72)	6.5"	4.8"	-	6.6"^{E}
McLeod above Embarras (1955-72)	9.1"	7.6"	11.9"	9.6"
Muskeg near Grande Cache (1972 only)	13.1"	-	16.2"	-
Simonette near Goodwin (1969-72)	5.3"	4.8"	7.6"	6.7"
Smoky above Hell's Creek (1968-72)	27.7"^{E}	22.9"	31.3"^{E}	27.1"
Smoky at Watino (1915-22,1955-72)	8.9"	7.6"	11.7"	9.6"
Snake Indian near the mouth (1971-72)	26.3"	25.0"	-	27.1"^{E}
Wapiti near Grande Prairie (1918,1961-72	11.3"	9.6"	15.1"	12.2"
Waskahigan near the mouth (1968-72)	4.6"	3.7"	6.2"	5.3"
Wildhay near Hinton (1965-72)	8.1"	8.6"	-	10.2"^{E}
Wampus Creek nr. Hinton	10.9"	8.5"	-	10.0"^{E}

Figure 2.10



MEAN ANNUAL RUNOFF
WATER YIELD ZONES

GRANDE PRAIRIE
EDSON
HINTON
JASPER
VL
L
M
H
LEGEND
H (High) - over 15"
M (Moderate) - 10" - 15"
L (Low) - 8" - 10"
VL (Very Low) - under 8"

runoff is unclear at present, but protection of a water resource of this magnitude is obviously in the public interest.

2.4.4 Floods

Localized flooding occurs periodically along the east slope. Structural damage is generally limited to roads and bridges.

Heavy rains over the northwestern part of the project area in June, 1972, caused record flows in most of the streams in that region. Most of the watersheds in the region suffered extensive streambank damage, especially in areas of sensitive deposits and natural slumping. The flood plains of the larger rivers such as the Wapiti and Smoky were also inundated as a result of the bulking effect of tributary flows. Damage to roads, bridges, property, and the Alberta Resources Railway was estimated at several million dollars. The flood was rated as a once-in-a-century event (Warner and Thompson, 1972). It is evident that past planning by most agencies has not been based on a full appreciation of stream behavior.

2.4.5 Water Quality

a) Turbidity

The conditions of terrain, surface materials, and climate described in foregoing sections inevitably lead to the presence of appreciable sediment loads during heavy runoff periods. The on-going downward cutting of streambeds extremely recent in origin is a major contributing factor. Quantitative assessments within the project area are sketchy, but aerial and ground observations made during the spring and summer of 1973 confirmed this theory. All rivers, although carrying subnormal snow-melt in May and June, were highly turbid (similar in color and opacity to strong coffee with added cream). Several small, undisturbed headwater streams cutting through unstable deposits were equally turbid as a result of primary bank cutting and slumping (e.g., Upper Sheep Creek). One extreme illustration of turbidity in 1973 was the Cutbank River system, whose very name suggests that the cutting process is far from new.

The June, 1972, storm event was reported (Short and Pinel, 1972) to have caused some degree of slumping to about 75 percent of the stream banks of Bull Creek, which drains a 42 square mile watershed in the Cutbank system. Slumping almost as intensive was noted in many other watersheds, especially in the northwest portion of the project area. It is probable that some 1973 turbidity was caused by downstream transportation of sediments brought within the reach of streams in 1972.

Low-water flows between September and March are accompanied by low sediment loads. During the winter and spring of 1972-73, all streams except the lower reaches of the five or six major rivers were clear, or faintly brownish from organic solutes.

Turbidity is inferred to be a natural phenomenon recurring each year but somewhat less pronounced in the Athabasca drainage than elsewhere. Human efforts to prevent this natural turbidity would be futile. Increased turbidity as a result of road construction and other activity would be possible, but the effects on water quality and on fish habitat would be less serious than in watersheds where natural tolerances to turbidity do not exist.

b) Chemical Solutes

Water analyses are fragmentary. From the prevalence of calcareous parent rock and soils, a concentration of $CaCO_3$ could be inferred for most waters. Humic acid from muskegs would also be common where muskegs are of significant size.

c) Pollutants

Effluents of municipal, pulpmill and mining origin are currently entering rivers of the area, under a degree of governmental control. Provincial standards for tolerable dilution are reportedly exceeded at times during low flow periods. Since these pollutants are beyond the scope of this report, it is assumed that they will be kept within prescribed limits and will therefore not nullify efforts to prevent pollution of waters by timber harvesting operations.

2.4.6 Groundwater

The water table appears to lie close to the surface over most of the project area, since most soils whether on slopes or level ground are underlain by impervious bedrock or clay. Much of the Grande Prairie Forest exhibits zones of saturation and springs from groundwater trapped above impervious clay strata or lenses. Notable exceptions are present on plateau or ridge deposits of Continental Till. One such site near Kakwa Lookout required drilling to a depth of 280 feet for procurement of a water supply for a forty-man camp.

2.4.7 Erosion Evidence

Current erosion evidence is associated very largely with road excavations, particularly at intersections of roads and streams.

The extent, particulars, and probable control measures are described in later chapters.

Sheet erosion of lands denuded of vegetation but not bared to mineral soil is less common, but has been documented regionally in one case. Wyldman and Poliquin (1973) have reported soil losses from a single storm in the Swan Hills area, which is outside the project area. The area denuded was on a slope of approximately 30 percent. The results of a storm lasting from September 2 to 5, 1969, were as follows:

Station	Total Precip.	Max. Precip. in 24 hrs.	Soil Loss in Tons/Acre	Equiv. Thickness of Soil Removed (Inches)
1	3.16"	1.65"	22.0	0.12
2	3.12"	1.64"	7.2	0.04
3	3.10"	1.50"	4.2	0.02
4	4.63"	2.08"	6.5	0.04

Conditions of slope, rainfall, and soil similar to those illustrated are not uncommon within the project area, and will be reached more frequently in future by cutting operations. These findings illustrate the importance of prompt revegetation following denudation.

A few instances of erosion caused by overgrazing were noted. For example, in the vicinity of Grande Cache, limited steep range lands appear inadequate for support of wild horses and game.

The aeolian deposits near Brule Lake are susceptible to wind erosion following removal of timber. Aeolian deposits occur elsewhere, but seldom support merchantable timber stands.

2.4.8 Watershed Sensitivity

The combined effects of material stability and slope have been described and mapped as Erosion Sensitivity (Section 2.1.5). The variable of precipitation can now be added, and these three major variables combined, perhaps imperfectly, for the classification of individual subwatersheds. Table 2.5 lists forty subwatersheds within the project area. Each was given a localized soil stability rating (H, M, or L). Each was then rated in terms of summer precipitation, location relative to summer storm tracks, and intensity of storm precipitation. A Watershed Sensitivity Index was developed on the basis of these combined variables, and the subwatersheds arranged in the table in rough order from High sensitivity (H) to Low sensitivity (L). Subwatersheds appearing highest on the list (Copton, Upper Wildhay, Upper Kakwa, et al.) exhibit compounding of high surface sensitivity with high storm frequency and intensity.

The Watershed Sensitivity Overlay (Volume 2) shows, by shading, the pattern of these "H" subwatersheds.

It should not be inferred that all parts of an "H" watershed are equally sensitive, nor that "L" watersheds are free from areas of local sensitivity. Nevertheless, it can be inferred with some confidence that the planning and control of timber harvesting should be more strict in the "H" classification than in "M" or "L" classifications.

TABLE 2.5

ANALYSIS OF WATERSHED SENSITIVITY

		Percent of Watershed in Soil Stability Classes 3 and 4				Precipitation Parameters			
Ref. No.	Watershed	Class 3 Unstable	Class 4 Very Unstable	3 plus 4	Assigned Rating 3 plus 4	Precip. Zones May-Sep	Storm Tracks & Centers	Frequency of precip. in 24 hrs. (0.5-1.5")	Watershed Sensitivity Index
1	Copton Cr.	-	86.0	86.0	H	M	M	H	H
2	Wildhay R.(upper)	3.5	79.0	82.5	H	M	M	H	H
3	Kakwa R.(upper)	1.0	72.0	73.0	H	M	M	H	H
4	Athabasca-Brule	8.5	57.5	66.0	H	M	M	H	H
5	Pembina R.	-	54.0	54.0	H	H	H	H	H
6	Torrens R.	2.5	45.5	48.0	M	H	H	H	H
7	McLeod R.(upper)	2.7	32.0	34.7	M	H	M	H	H
8	Deep Valley Cr.	24.5	2.0	26.5	M	H	M	H	H
9	Tony Cr.	11.5	13.5	25.0	M	H	M	H	H
10	Narraway R.	2.5	20.5	23.0	M	M	H	H	H
11	Nose Cr.	0.5	21.0	21.5	M	M	H	H	H
12	Cutbank R.(upper)	-	16.0	16.0	L	H	H	H	H
13	Pine-Windfall-Oldman	88.8	-	88.8	H	M	M	M	M
14	Muskeg R.(lower)	4.6	78.5	83.1	H	L	L	M	M
15	Sheep Cr.	1.5	70.0	71.5	H	M	L	H	M
16	Smoky R.(above Hells Cr.)	-	64.0	64.0	H	M	L	H	M
17	Smoky R.(Muskeg)	-	54.0	54.0	H	M	L	H	M
18	Edson R.(east)	50.0	-	50.0	H	M	L	L	M
19	Edson R.	50.0	-	50.0	H	M	L	H	M
20	Prairie Cr.	-	48.5	48.5	M	M	M	H	M
21	Wildhay R.(lower)	28.0	6.8	34.8	M	M	M	H	M
22	Jarvis Cr.	16.5	15.5	32.0	M	M	M	H	M
23	Smoky R.	4.0	18.5	22.5	M	M	M	H	M
24	Muskeg R.(upper)	3.0	18.5	21.5	M	M	L	H	M
25	Athabasca R.	18.0	3.0	21.0	M	M	L	H	M
26	Little Smoky R.	15.0	5.5	20.5	M	M	M	H	M
27	Berland R.	11.5	7.5	19.0	L	M	M	H	M
28	Pinto Cr. (south)	16.0	1.5	17.5	L	M	M	H	M

TABLE 2.5 - continued

Ref. No.	Watershed	Class Unstable	Class 4 Very Unstable	3 plus 4	Assigned Rating 3 plus 4	Precip. Zones May-Sep	Storm Tracks & Centers	Frequency of precip. in 24 hrs. (0.5-1.5")	Watershed Sensitivity Index
29	McLeod R. (lower)	4.0	10.6	14.6	L	M	L	H	M
30	Pinto Cr. (North)	-	14.5	14.5	L	M	M	M	M
31	Kakwa R. (lower)	0.5	13.0	13.5	L	M	M	H	M
32	Simonette R.	6.5	6.5	13.0	L	M	M	H	M
33	Erith R.	-	13.0	13.0	L	M	H	H	M
34	Latornell R.	0.5	10.0	10.5	L	M	L	H	M
35	Cutbank R. (lower)	0.5	8.5	9.0	L	M	M	H	M
36	Embarras R.	-	7.0	7.0	L	M	M	H	M
37	Oldman Cr.	2.5	-	2.5	L	M	M	H	M
38	Economy Cr.	-	24.5	24.5	M	L	L	L	L
39	Big Mountain Cr.	-	10.0	10.0	L	L	L	M	L
40	Waskahigan R.	5.0	3.5	8.5	L	M	L	M	L

NOTE: The individual parameters were rated as follows:

H - 3   M - 2   L - 1

The sum of these determines the Watershed Sensitivity Index. A score of:

10 to 12 - High
7 to 9 - Moderate
4 to 6 - Low

2.5 Vegetation

Vegetation exerts an enormous influence on almost every aspect of environmental quality. Native plant species have colonized the project area following relatively recent glaciation. Many of these species are "pioneers", with adaptations which permit their survival under highly exposed conditions and in an extreme climate.

The project area is essentially forested. The general mosaic of the tree components is shown in the forest Type Overlay (Volume 2). Areas known to be clearcut since approximately 1955 are indicated on this map. More detailed cover maps, at larger scales, have been prepared for portions of the area by the AFS and holders of FMA's. None of these maps do more than suggest, however, the enormous variety of plant form living in intimate, shifting balance, on the area.

Human activities to date have interfered locally or temporarily with the natural successional pattern, but the immensity of the project area and the resilience of plant communities would make permanent alteration by man a difficult and lengthy process.

2.5.1 Phytogeographic Zones

According to Halliday's (1937) classification, modified by Horton (1956), the major portion of the project area can be divided into three phytogeographic zones: the lower foothills, the upper foothills, and the subalpine zone. An additional small amount of alpine zone occurs in the Grande Cache area.

a) The Lower Foothills

This zone extends from the mixedwood forests to the east and north of the project area to the upper foothills on the west. It covers a general range of elevation from 2500 to 4000 feet. Lodgepole pine (*Pinus contorta*) is the dominant tree, commonly mixed with aspen (*Populus tremuloides*), and often containing an understory of white spruce (*Picea glauca*). Black spruce (*Picea mariana*) and balsam poplar (*Populus balsamifera*) are found in scattered distributions, while the wet regions are dominated by willows (*Salix* spp.), alders (*Alnus* spp.), and water birch (*Betula occidentalis*). White spruce stands are common in unburned areas.

b) The Upper Foothills

The upper foothills zone ranges in elevation from 4000 to 6000 feet, extending from the lower foothills on the north and east and gradually succeeding to the subalpine forest on the west. White spruce mixes with lodgepole pine in this zone, pine being dominant in the more recently burned areas. With increasing elevation, white spruce gives way to Engelmann spruce (*Picea engelmannii*) and considerable hybridization occurs. Along the valley bottoms, white spruce may penetrate quite deeply into country that is otherwise dominated by Engelmann spruce.

c) The Subalpine Zone

Ranging from 4500 feet to timberline at 6500 to 7000 feet, the subalpine forest overlaps the upper foothills forest to a considerable degree. Engelmann is the dominant spruce, with white spruce being confined to the river valleys. Alpine fir (*Abies lasiocarpa*) is a common associate of Engelmann spruce, while white-bark pine (*Pinus albicaulis*) has a sporadic distribution at high elevations. In dry, exposed areas, the forest gives way to open grassland.

2.5.2 Patterns of Forest Succession

Throughout the forested regions of the project area, spruce is the climax tree species. White spruce is characteristic of lower elevations and valley bottoms, while at higher elevations Engelmann spruce predominates. At higher elevations, alpine fir is a commonly associated species, and in the lower regions black spruce and balsam poplar are common associates.

Despite the fact that spruce is the climax species, the predominant tree throughout the region is lodgepole pine (*Pinus contorta*). Its widespread occurrence is directly related to the incidence of fire. Historically, regular large fires have swept areas of the eastern slopes destroying the mature forest, thus re-establishing pioneer plant communities. Lodgepole pine is well suited for re-occupation of burnt areas, since the very fire which destroys one pine stand releases copious seed otherwise held in serotinous pine cones. Pine seedlings are well adapted for survival and rapid growth on most burned-over sites.

A common associate with pine at lower elevations is aspen (*Populus tremuloides*), (Horton 1965), which is also able to regenerate quickly following fires through the production of root suckers. Mixed pine-aspen stands are common in the lower foothills.

Pine and aspen are both intolerant of shade. Thus, as a stand matures, the understory of shade-tolerant spruce and associated species will gradually grow up and predominate (unless another fire sets the succession back again). In the foothills, fires have spared relatively few stands for longer than 150 years, and pine stands are therefore a common forest type.

2.5.3 Distribution of Major Plant Communities

The broad distribution of forest types within the eastern slopes region is dominated by changes in elevation, and attendant changes in climate. The lowlands in the northern and eastern regions of the project area support mainly deciduous and mixedwood forests (see vegetation map in Volume 2) characterized by a high proportion of aspen and lodgepole pine-aspen stands. With increasing elevation, this forest type gives way to pine-white spruce forest, and then to the white-Engelmann spruce forests of the higher regions. From the lowlands in the Grande Prairie region, to the upper reaches of the sub-alpine forests in the southwest of the project area, an elevation change of over 5000 feet is traversed.

Within the general distribution pattern described above, other environmental factors cause local changes in plant community distributions.

Fire has been shown to set communities back to early successional stages and could, as a result, change a spruce-dominated community into one of pine or pine-aspen.

The climatic differences between valleys and the surrounding country often have substantial effect upon vegetation. River valleys tend to be more humid and to possess more moderate temperature fluctuations than adjacent slopes. A common pattern of plant community distribution seen in the project area is that of river valley bottoms supporting mixedwood and deciduous growth while the surrounding land is covered with conifer growth. This pattern can be seen on the Forest Type Overlay and is important in determining distributions of winter wildlife habitat. Detailed forest cover maps show this pattern better and illustrate the influence of relatively small streams on their bordering vegetation.

In mountainous terrain, slope and aspect play a considerable role in community distributions. Severe slopes are accompanied by land slumping, a condition that can give rise to grassland or scrubby brush being found in coniferous forest areas. North-facing slopes are, on the average, colder and damper than south-facing slopes. In alpine river valleys, north-facing slopes may often be forested while south-facing slopes are grass covered or support sparse, open timber stands.

Soil characteristics also influence the type and vigor of vegetation. This is discussed above in relation to timber crops, but is also true of lesser vegetation.

In summary, the distribution of plant communities on the project area is characterized by deciduous and mixedwood forests occurring in the northern lowlands of the study area (below approximately 3000 feet) and along major river valleys while coniferous forest, pine, spruce-pine, or spruce, covers most of the remainder.

2.5.4 Characterization of Plant Communities

The main plant communities are dominated by forest tree species. Non-tree species are nevertheless numerous and of major environmental importance, particularly after disturbances. Ten identifiable plant communities, together with the appropriate proportion of the project area covered by each, are:

Recently burned (past 20 years)	2%
Recently harvested (past 20 years)	6%
Deciduous forest	7%
Mixedwood forest	12%
Pine forest	33%
Spruce-pine forest	14%
Spruce-fir forest	8%
Riparian	1%
Bogs	8%
Alpine	7%
Permanently unvegetated (lakes, rock, icefields, etc.)	2%
	100%

The characteristics of each are described briefly below, with supporting detail in Appendix II-2.

a) Recently Burned

- snags and debris may impede game movement and constitute future fire hazard, but may assist in soil-holding and shading functions;

- mineral soil is largely exposed, at least where fire has been intense;

- restocking by pioneer species, notably fireweed, aspen, and pine. Restocking is by seeding and by vegetative reproduction of woody perennials;

- Pine stocking, usually extremely dense and often resulting in eventual suppression of understory and ground vegetation.

b) Recently Harvested

- debris is light and generally flat on ground. Snags are absent;
- mineral soil not generally exposed, except on skidroads or by artificial scarification;
- coniferous restocking usually less dense than in (a). Browse and shelter may develop more slowly than in (a), but may persist longer;
- residual vegetation, unmerchantable by reason of species or size, remains standing. Small conifers become a component of the new timber crop.

c) Deciduous Forest

- dominated by aspen, associated with balsam, poplar and birch on moist sites;
- deciduous character permits understory vegetation, including young conifers, to survive or flourish;
- browsing potential is abundant throughout lifetime of stand.

d) Mixedwood

- the major forest cover in lowlands, often but not necessarily of fire origin;
- midway in character between deciduous and coniferous forest;

- tends to evolve into spruce climax forest at advanced age, through mortality of deciduous component.

e) Pine Forest

- the characteristic evenaged stand of fire origin, on upland, well-drained sites;

- understory species present, but often poorly developed due to density of the overstory until decadence;

- browze available, but less abundant than in (c), (d), or (g).

f) Spruce-Pine Forest

- a mature successional stage of (e) or alternatively an evenaged stand developed under favorable restocking conditions for spruce;

- midway in character between (e) and (g).

g) Spruce-Fir Forest

- often a late successional stage, and no longer evenaged. Capable of self-perpetuation without major changes;

- characterized by shrubs, herbs, and ferns in openings, and by mosses and lichens throughout stand. Understory and browze potential is thus greater than in (e) or (f).

h) Riparian Vegetation

- characterized by hydrophylic plants;
- conifers excluded by high water table;
- rich game habitat.

i) Bogs

- plants adapted for survival in saturated, acidic, organic soils;
- conifers scattered and of extremely slow growth; black spruce and tamarack;
- favorable habitat for moose and birdlife.

j) Alpine

- pioneer plant communities, with slow and precarious advance to more complex communities;
- rich forage for wildlife, unless overcropped or disturbed.

2.6 Wildlife

2.6.1 Big Game

Distribution and Habitat

The project area is one of the prime big game hunting areas in Alberta. Healthy populations of mule deer, moose, elk (wapiti), and black bear are found here. In addition, mountain caribou, grizzly bear, rocky mountain sheep and mountain goats are found in certain zones. Particulars of the distribution and habitat requirements of each species are outlined below.

Data on distribution come primarily from sources within the Alberta Department of Lands and Forests, Fish and Wildlife Branch. A number of aerial surveys have been carried out within the project area, most by the Fish and Wildlife Branch (Lynch, 1971; Lungle, 1971). The aerial survey techniques used in these surveys have proven to be reliable for sheep and goats and are being improved for moose, but are not adequate for other big game species. Ground examinations conducted in the course of this study, however, tended to confirm previous information.

Habitat information has been taken from a number of available references. Scientific names are from Soper (1964).

The Fish and Wildlife Overlay (Volume 2) illustrates what is presently known about key ranges of big game in the project area. "Key ranges" refers to important wintering areas for the ungulate big game as well as important habitat necessary to the local populations of caribou and grizzly bears. The map was adapted primarily from a similar map provided by the Multiple Use Planning Section of the Departments of Lands and Forests.

However, information obtained during interviews with regional biologists has been incorporated, and selected sites were inspected. The locations of these transect sites are shown on the Fish and Wildlife Overlay (Volume 2).

1. White-tailed Deer (*Odocoileus virginianus*) and Mule Deer (*Odocoileus hemionus*)

a) Distribution

The white-tailed deer in Alberta is primarily an animal of the plains, and is not found to any great extent in the mountains or foothills (Soper, 1948, 1964). There are, according to Edson regional biologist G. Lynch, a few white-tailed deer near Brule, Hinton and Edson (personal communication). The mule deer is the predominant deer species found within the project area and is moderately common throughout. Aerial surveys have proved ineffective in censusing mule deer populations because of the animals' small size and shyness (Lynch, 1971).

Important deer wintering areas have been observed along the Smoky, Kakwa, Cutbank, Wapiti and Simonette rivers, as well as on Cutpick Hill and Grande Mountain and along Sheep Creek north of Mount Hamell.

b) Habitat

Deer are animals of early successional forests, deciduous and shrub growth (Cowan, 1952). They are commonly associated with forest edges, where browse is readily available. They succeed well in second growth areas following fire or logging (Leopold, 1950), provided that there is adequate cover.

In mountainous terrain, deer will often move to lower elevations in winter, seeking exposed south-facing slopes when the cold weather is oppressive (Loveless, 1964). Another common winter range is in mixedwood forests. Here the deciduous growth (willow, aspen, etc.) provides winter food while the conifers provide shelter from severe cold and deep snow, to which deer are extremely sensitive. In spring they move back up the slopes.

Deer are predominantly browsing mammals, relying heavily upon forbs and shrubs, but their feeding habits vary somewhat with the seasons. A study of mule deer in the Sheep River region in high terrain south of the project area (Sheppard, 1960) observed the following feeding pattern. In spring the deer fed heavily on new shoots of grass emerging on exposed slopes. This was the only time of year that they were observed to be grazers to any extent. As summer approached they switched their attention to the flowering plants. Many species were eaten, among the most important of which were dandelion, milkvetch, fireweed, and Hedysarum. Shrubs eaten at this time included willow, wild rose, and alder. In the fall, the deer utilize mainly shrubs and trees such as chokecherry, aspen and saskatoon berry. During winter, the deer browsed mainly upon trees amd shrubs such as willow, aspen poplar, chokecherry, saskatoon berry, and conifers.

2. Elk or Wapiti (*Cervus canadensis*)

a) Distribution

Aerial surveys in the project area have recorded elk both in sub-alpine terrain and along rivers (Lynch, 1971). The Berland River, Wildhay River, and Pinto Creek seemed to be particularly good for elk. However, these aerial studies were judged to be "completely useless" in arriving at a census of elk in the area (Lynch, 1971). Other important elk wintering areas include the headwaters of the Muskeg, Little Smoky, Simonette and Wapiti rivers, along the Cutbank and Kakwa rivers, the Rock Lake area, and Sheep Creek north of Mount Hamell.

b) Habitat

Like deer, elk are inhabitants of early successional forest stages (Cowan, 1952) but they require more cover than do the smaller deer. They often prefer grassy mountain slopes in warmer months, but move down to lower elevations to overwinter (see Wildlife map).

Elk are grazers to a much greater extent than are deer. In the Hinton area, grass is is preferred throughout the year; the grasses most palatable to elk are those of the genera *Poa*, *Bromus*, *Agropyron*, and *Melica* (Stelfox, 1963). Wheat grass (*Agropyron*) is especially important as a winter food. Sedges are also eaten extensively and at all times of the year. When snow is deep in winter, the elk browse plants such as fir, saskatoon berry, birch, silverberry, pine, aspen poplar, chokecherry, rose and willow (Stelfox, 1963). On a range in southwestern Montana, the winter food of elk was observed to consist of 60 percent grass (mainly wheat grass and fescue), 30 percent browse (mainly sagebrush), and 10 percent forbs (Constan, 1972).

3. Moose (*Alces alces*)

a) Distribution

Aerial surveys of moose have been carried out in large portions of the project area. A recent survey of 576 square miles along the Wapiti River (Lungle, 1971) revealed an average of 3.45 moose per square mile. It was felt that this estimate was in the order of 60 percent of the population. When broken down among habitats, the observations were as follows: 1.62 moose per square mile in coniferous forests, 2.30 moose per square mile in muskeg, 3.37 moose per square mile in mixedwood forest, and 4.72 moose per square mile for deciduous growth (particularly willow).

Other aerial surveys (Lynch, 1971), which were judged to be about 1/3 less effective in spotting moose than the above, observed densities of moose ranging from 0.1 to 1.7 moose per square mile with a figure of 1.2 moose per square mile being roughly an average density. Spottings along rivers indicated that the Berland River, Wildhay River and Nosehill Creek had high moose densities.

In general, the entire project area appears to be good moose habitat. Areas of winter concentrations are shown on the Wildlife Overlay map in Volume 2.

Some of the more important of these are the headwaters of the Little Smoky, Simonette, and Wapiti rivers; the Berland River in the Berland - Huckleberry fire tower area; Rock Lake; Cutpick Hill; Grand Mountain; Copton Ridge; the Smoky and Cutbank rivers, and along the Embarras River near Coalspur.

The following observations of moose are reported by the Fish and Wildlife Branch for Wildlife Management Units (W.M.U.) in the lower elevations of the project area. Most of the data come from aerial surveys using the "line transect" method of censusing which is known to be not adequately effective in spotting all the animals (Lynch, 1971). The data for Wildlife Management Units (W.M.U.) 356 was obtained using the "quadrant method" which is reported as being almost three times as efficient as the line transect method in censusing moose populations (Lungle, 1971).

W.M.U.	MOOSE PER SQUARE MILE (MEAN) 1967-68	1968-69	1970-71
F340	0.6	1.3	-
F342	0.5	1.3	-
F344	1.0	1.2	-
F346	1.5	1.4	-
F352	-	1.4	0.4
F354	1.2	-	-
F356	-	-	3.45

Moose observations in the project area (from Lynch, 1971; and Lungle, 1971).

b) Habitat

The moose is an animal of mixedwood forests and thickets whose habitat often includes lakes, ponds, streams or bogs (Soper, 1964). It is also found in the sub-alpine forests, particularly in more open stands.

In winter, moose will congregate in low areas of deciduous growth where they can find available browse, particularly willow. Since moose can tolerate very cold weather and relatively deep snow, they can winter in more open deciduous areas than deer.

A study of moose in the Rock Lake region 35 miles west of Entrance (Millar, 1953) provides some information on the feeding habits of the animals. In winter, the moose concentrated on the lower flats feeding mainly on willow. In mild periods some moose ranged upward, probably to feed on alpine fir, another favored food. In summer, aquatic feeding was common in the lake. However, in the hot months the moose moved into higher timbered area to escape flies and here they fed mainly on willow, aspen poplar, balsam poplar, and some birch. They fed mainly by stripping leaves off the shrubs, leaving the buds intact and therefore not greatly impeding the plant's growth. Spruce shoots were evidently unpalatable to moose, and lodgepole pine was eaten in only small amounts although it was abundant. Millar also mentions that fir, high bush cranberry, and red osier dogwood are readily eaten by moose in other areas, but were not found eaten to any degree in his project area.

4. Rocky Mountain Sheep (*Ovis canadensis*)

a) Distribution

Aerial surveys (Lynch, 1971) have indicated that sheep are distributed throughout the alpine zones along the western border of the project area (Wildlife Management Unit numbers S436 to S446, with the exception of S441 near Grande Cache which is largely lowland terrain). Most sheep sightings have been made in the southwest portion of the study area, immediately north of the Willmore Wilderness Area. Sighting locations include Sheep Creek north of Mount Hamell, Mount Torrens, Lynx Creek, South Kakwa River west of La Greche Mountain, and along Horne, Swift and Famm creeks. In the adjacent Willmore Wilderness Area, heavy sheep concentrations occur in the Hoff, Berland, and Persimmon ranges (M. Quaedvlieg, personal communication).

W.M.U.	GEOGRAPHIC AREA	NUMBERS OF SHEEP SEEN 1967	1968	1969	1971	1973
S437	Cadomin Mtn.	23	-	-	12	-
	Red Cap Mtn.	52	-	-	103	-
S438	Folding Mtn.	23	85	-	-	-
	Luscar Tower	5	81	-	-	-
	Fiddle Pass (Leyland Mtn.)	37	18	-	68	-
	Harlequin Creek	38	60	-	-	-
	Cheviot Mtn.	0	55	-	-	-
S439	Brule Tunnel	39	45	-	-	-
	Black Cat Mtn.	13	48	-	-	-
S442	Sheep River	-	-	-	-	10
	Horne Creek Complex	124	135	59	-	71
	S. Kakwa River		-	-	-	10
S444		45	0	122	-	-
S445	Mt. Torrens	-	-	-	-	23
	Lynx Creek	-	-	-	-	52

Sheep observations in the project area (from Lynch, 1971, 1973 from M. Quaedvlieg, personal communication).

b) Habitat

Sheep are animals of the alpine grasslands and other areas above timberline. In winter they may descend to valleys or old burns, or seek wind-swept, south-facing slopes where they can find forage.

Sheep are primarily a grazing animal, utilizing grasses and sedges throughout the year (Wishart, 1958). They will browse to some extent on meadow forbs in the late summer. Wishart (1958) stated that the special habitat requirement of sheep is that they must have winter forage areas which are in close association with escape terrain. Mineral licks may also be important to the sheep's habitat and migrations.

5. Mountain Goat (*Oreamnos americanus*)

a) Distribution

The only observed goat herds in the area are in the Grande Mountain - Goat Cliff region, along Pinto Creek, Mount Hamell, and Black Cat Mountain. Within the Willmore Wilderness Area, goats are common in the Hoff, Berland and Persimmon ranges.

W.M.U.	GEOGRAPHIC REGION	NUMBER OF GOATS SEEN 1967	1968	1969	1973
S438	Folding Mtn.	-	2	-	-
S439	Black Cat Mtn.	4	6	-	-
S441	Grande Mtn. - Goat Cliffs	-	-	-	approx. 70
S444	Mt. Hamell	-	11	49	-

Mountain goats observed in project area (from Lynch, 1971, 1973 data from M. Quaedvlieg, personal communication).

b) Habitat

The typical habitat for goats is the high alpine where grassy slopes adjoin rocky crags and cliffs. They are found in very rugged terrain.

Goats feed on a variety of alpine grasses, forbs, and twigs and leaves of several trees and shrubs (Soper, 1964). Like sheep they are strongly attracted to mineral licks.

6. Rocky Mountain Caribou (*Rangifer tarandus*)

a) Distribution

This is a closely related form of the woodland caribou which is found in several locations across Canada (Cringan, 1957). In 1966, the number of mountain caribou in Alberta was estimated at 1,285 to 1,635, all concentrated in the Rock Mountain alpine and sub-alpine zones (Burgess, no date). Caribou have been seen in higher elevations during sheep counts (Lynch, 1971) but the aerial observation techniques were not good enough to allow a census to be made. Caribou concentrations occur along the upper Kakwa and Smoky River drainages, along the Narraway and Torrens River, and east and west of Pinto Creek (Burgess, no date). A herd of caribou is known to winter near Pierre Grey Lake. Other caribou wintering areas are the headwaters of the Muskeg and Little Smoky Rivers, and the Berland River in the Berland - Huckleberry fire tower region (G. Lynch and M. Quaedvlieg, personal communication).

b) Habitat

Cowan (1952) states that "the mountain caribou is unique in requiring juxtaposition of two plant formations in climax stage: the alpine tundra in summer and over-mature spruce forest in the winter".

Studies in Ontario (Cringan, 1957) and British Columbia (Edwards and Ritcey, 1960) point out the feeding dependence of this caribou on lichens. Ground lichens such as reindeer moss are used, but tree lichens in mature conifer stands become almost the only forage available during periods of deep snow.

7. Black Bear (*Euarctos americanus*) and Grizzly (*Ursus arctos*)

a) Distribution

Little detailed information is available for either of these species in the project area. The black bear is abundant throughout the area, probably being concentrated in mixedwood habitats close to streams and lakes. The grizzly is more at home in mountainous terrain, and is reported by biologist Gerry Lynch (personal communication) to be present in good numbers in the sub-alpine areas in the headwaters of the Kakwa River, in the Copton Creek area, and in the Smoky River region (see Wildlife map).

Both bear species are omnivorous, eating meat, insects, forbs, berries, roots and grasses as they find them. The grizzly is more of a carnivore than the black bear and can often be seen in pine meadows digging after ground squirrels, pikas and other small mammals (Cahalane, 1961).

In a study in a northwestern Montana spruce-fir forest, Jonkel and McTaggart-Cowan (1971) found two major types of black bear habitat: heavily treed lower elevation forests and areas which were thinly forested and high in elevation. Clearcut areas were largely avoided. Grizzly bears used a similar habitat to black bears, but were more concentrated in the high country during the summer and fall.

2.6.2 Small Mammals

The fur bearing mammals are trapped within the project area. These species are listed below, in order of trapping abundance, together with their individual feeding and habitat preferences.

	Species	Habitat	Feeding Preference
1.	Red Squirrel (*Tamiasciurus hudsonicus*)	Seed-bearing coniferous forest	Conifer seeds
2.	Beaver (*Castor canadensis*)	Ponds, slow-moving streams	Twigs of aspen and willow
3.	Muskrat (*Ondatra zibethica*)	Ponds, slow-moving streams	Aquatic vegetation
4.	Weasel (*Mustela erminea*)	Upland forests	Rodents, birds
5.	Lynx (*Lynx canadensis*)	Mixedwood forests	Hares, grouse, small rodents
6.	Coyote (*Canis latrans*)	Mixedwood forests	Grouse, rodents
7.	Marten (*Martes americanus*)	Seed-bearing coniferous forests	Squirrels
8.	Mink (*Mustela vison*	Streamside forest	Muskrat, amphibians, rodents, birds

Twenty-eight additional small mammal species were identified by Soper (1947-1948) in mountain and lowland habitats near Grande Prairie. These and the species trapped are listed in Appendix II-3 together with Soper's estimates of relative abundance. All appear to be adapted to forest or alpine conditions. Only massive and widespread destruction of these conditions would seriously threaten the species within the area.

2.6.3 Birds

Upland game birds occur widely on the project area. Those commonly sighted are listed below, with an indication of feeding and habitat preferences.

	Species	Habitat	Feeding Preference
1.	Spruce Grouse (*Canachites canadensis*) and Franklin's Grouse (*Canachites franklini*)	Coniferous and mixedwood forest	Buds, berries, insects, (spruce or pine shoots in winter)
2.	Blue Grouse (*Dendragapus obscurus*)	Summer - Mixedwood forest Winter - Sub-alpine forest and meadow	Buds, berries, insects, conifer shoots
3.	Ruffed Grouse (*Bonasa umbellus*)	Deciduous and mixed forest	Aspen, willow, rose buds, berries, insects (well adapted to cut-overs)

4.	Sharp-tailed Grouse (*Pedioecetes phasianellus*)	Open grasslands	Seeds, buds, berries, insects
5.	White-tailed Ptarmigan (*Lagopus leucurus*)	Alpine meadows	Buds, berries, insects

A large number of species in addition to those above occur on the area. Appendix II-4 lists all bird species thought to occur (Soper, (1947, 1949) and 1973 observations). Relative abundance and preferred habitat are indicated for each. A slightly larger number of species (67) frequent deciduous forest than mixedwood (59 species) or coniferous (56 species) forest. Even more species appear to frequent cutovers and burns; this difference is probably genuine, but may reflect mere ease of observation. Waterfowl, gulls, and shore birds are noted on water or marsh habitats as would be expected. Several terrestrial species, however, both prey and predator, also occupy these wet sites.

2.7 Fish

Most of the fish species noted for Alberta occur within the project area, but those frequenting large lakes and downstream reaches of rivers naturally do not. Important sporting species within the Peace tributaries and Athabasca drainage are:

	Peace Drainages	Athabasca Drainages
Salmonids		
Dolly Varden Trout	common	common
Eastern Brook Trout	rare	McLeod River only
Rainbow Trout	rare	common
Lake Trout	absent	Rock Lake only
Other		
Mountain Whitefish	common	common
Pike and Perch	common	common
Arctic grayling	common	common
Walleye	downstream	downstream

More species and generally better fishing are reported in the Athabasca system, perhaps as a result of reduced turbidity. A more detailed tabulation, by individual drainages and with more detailed habitat assessments and species distributions, is shown in Appendix II-5. This is based on unpublished Canada Land Inventory information. This information is acknowledged to be cursory and highly tentative.

In an effort to substantiate this information, and simultaneously to assess the impact of various operations on fish populations, field observations were taken in June and July, 1973. Fish populations were sampled, temperatures measured, notes on habitat suitability were made, and road crossing installations evaluated in terms of fish migration. These evaluations were made at 121 observation points visited throughout the project area. Results of all checks are tabulated in Appendix II-6. Species observed directly or collected by seine net, explosive stunning, or other means included:

Trout-Char-Grayling:	Warm-water species:
Rainbow Trout	Mountain Whitefish
Dolly Varden Char	Coarse fish
Eastern Brook Char	Sculpin
Arctic Grayling	Pike
	Burbot
	Sucker spp.

The distribution of sampled sites suitable for fish habitat is summarized as follows:

	Peace Drainage			Athabasca Drainage		
	Trout-Char Grayling	Warm-Water spp.	Total Sites	Trout-Char Grayling	Warm-Water spp.	Total Sites
Suitable habitat	18	3	21 (36%)	43	1	44 (70%)
Marginal	19	2	21	16	-	16
Suitable or Marginal	37	5	42 (72%)	59	1	60 (95%)
Unsuitable sites	-	-	16			3
TOTAL, all sites			58			63

The superiority of the Athabasca drainage sites (70 percent suitable, 95 percent suitable or marginal, and only 5 percent unsuitable) is confirmed, and the preponderance of cold-water, trout-char-grayling sites is apparent.

The Peace drainage sites (36 percent suitable, 72 percent suitable or marginal, and 28 percent unsuitable) contrasts appreciably, and a larger proportion of warm-water habitat is suggested.

Stream-road crossings are numerous in the area, and are affecting fish habitat. Appendix II-7 contains detailed observations taken at some 193 crossing sites, either in fish streams or in smaller streams tributary to fish streams. These observations include those in Appendix II-6, augmented by additional sites examined in August. Locations of all sites examined are shown on the Fish and Wildlife Overlay (Volume 2).

Of all sites examined, 65 (30 percent) exhibited some problem associated with road crossings and affecting existing or potential fish populations. Culvert installations and erosion, or siltation of fills or ditches, were commonly the source of these problems.

2.8 Other Fauna

Wild horses are present in the Grande Cache and Hinton areas, where they compete with other grazing ungulates. Amphibians and other aquatic fauna are present and undoubtedly figure in the food chain supporting higher orders of life. Insects also support these food chains. Some insects are a potential threat to timber crops. All are evident during the relatively short summers, and dormant in other seasons. Decomposing organisms, important in forest and associated environments, also are limited by the temperature regime.

Formal investigations of these other fauna were not made except where important influences on land management were established.

2.9 Scarce or Threatened Species

No form of plant life appears in danger of local extermination under current management practices.

Wood buffalo herds have been absent from the project area since the turn of the century. The potential restrictions on several ungulates have been noted. Predators of all species, because of their life cycle, terminal position in food chains, and incompatibility with human occupation, are probably declining gradually in this area as elsewhere.

A list of animal forms which will require attention and consideration in management to prevent gradual population declines should include:

	SPECIES	THREAT
Big Game	Mountain Caribou	Mature timber requirement
	Mountain sheep and goat	Grazing competition
	Grizzly bear	Human encroachment
	Cougar	Human encroachment
Small Game	Lynx	Trapping and hunting
Birds	Bald eagle	Chemical misuse, destruction of key habitat
	Golden eagle	
	Peregrine falcon	
Fish	Trout-char spp.	Stream-blocks at road crossings

2.10 Demographic and Industrial Factors

2.10.1 Population

The population of the project area is estimated at approximately 8,000 people. The concentration of approximately 90 percent of the people in two towns, Hinton and Grande Cache, illustrates the primary, extractive-type industry base of the area. The balance of the population is sparsely distributed from Mountain Park in the south to Shuttler Flats in the north in small hamlets and settlements, sawmills, oil pipeline pumping stations, forestry stations, and isolated cabins.

It is important to emphasize that the sub-region formed by the project area has some distorting demographic features. Immediately adjacent to its boundaries are the major population centers of Grande Prairie and Edson. The population of Grande Prairie, and to a lesser extent of Edson, derive substantial portions of their income from within the project area. Thus, discussions of resident per capita incomes on the project area are not relevant.

The project area is one of the few areas of rural Alberta that is presently not losing its population to the urban areas of Alberta. The reason is the resurgence of the coal mining industry and the growth of the forest industry. The coal mining industry was once before a major factor in the economic vitality of the area. The "Coal Branch" region along Highway 47 during the 1920's, 30's, and 40's was a substantial producer of coal until coal lost markets to gas and oil.

2.10.2 Industry

The three major industries are extractive: timber harvesting, coal mining, and petroleum extraction. Industries of secondary importance include: the transportation and travel support industry, hunting and guiding, general service industry and recreationally-oriented services. Agriculture is of minor importance.

Table 2.5(a) indicates the relative magnitude of the provincial output of the three primary industries of the project area.

TABLE 2.5(a)

ALBERTA PRODUCTION VOLUME AND VALUE OF PETROLEUM PRODUCTS, COAL, AND FOREST PRODUCTION

	Units	Valuation $
Oil, Natural Gas and By-products	462,471 M bbl. -1,881,543 MM cu. ft.	1,534,329,000
Coal	8,931,468 (tons)	41,837,437
Forest Production	129,916 M cu. ft.	53,015,846

Source: A.B.S., Industry and Resources, 1973

Petroleum Extraction

The exploration and processing of oil and gas presently takes priority over previous land use claims. The highly competitive bid system of granting provincial oil and gas reserves and leases means that in the short-term some inefficiencies result in terms of multiple land-use. These inefficiencies largely take the form of sub-optimal placement of access roads and the destruction of minor quantities of merchantable timber.

The actual drilling location is typically four acres or less in size and the acreage requirements for processing plants are relatively modest as well. The seismic exploration programs require the clearing of long tangents called seismic lines.

In the past, exploration companies would often parallel competitive oil companies's seismic lines. This wasteful and environmentally disruptive process is now prohibited by the Department of Lands and Forests and seismic exploration is, where possible, confined to existing lines. The estimated cleared land in the project area from seismic lines is about 58,000 acres. Including pipelines, drilling and processing plant sites, and access roads, the petroleum industry occupies or has temporarily removed from timber production appoximately 65,000 acres.

Successful gas finds resulted in the construction of large gas processing plants at Gold Creek and north and west of Edson. Although of undeniable importance to the Provincial economy, this industry is not a source of major permanent local employment.

Coal Mining

It is estimated that Alberta has 39 percent of Canada's coal reserves. Of the estimated 11 million tons produced in the province in 1972, approximately 27 percent was represented by bituminous coal mined from within the project area at Grande Cache and Luscar.

The town of Grande Cache was created to service the McIntyre Porcupine Mines and the community, with a population of approximately 2,500, is entirely dependent upon the mine operation for its viability.

The Luscar operation of Cardinal River Coals Limited is approximately 30 miles south of Hinton. Approximately 80 percent of the company employees live in Hinton.

Coal Leases

The lands leased for potential coal mining are shown on the Energy Development Map (Volume 2). The coal leases form an intermittent strip about 20 miles wide running from the western boundary of the project area near Two Lakes southeast to Pembina Forks near the southern boundary. This belt includes Grande Cache and Luscar. There is also a group of leases of about 10 square miles between the Smoky and Kakwa Rivers south of Musreau Lake. A further lease of one square mile is near the McLeod River northwest of Fickle Lake.

The leases are about one-half on the Procter & Gamble Forest Management Area, one-quarter on the North Western Pulp and Power Forest Management Area, and one-quarter on Crown Land.

It is noted that one and a half square miles of the Kakwa Natural Reserve and 60 square miles of the Willmore Wilderness are under lease, and that coal leases in the vicinity of Folding Mountain are the subject of lively land use debates.

The leases tend to skirt the higher elevations with most situated in the foothills zone. Probably over one-third of all coal lease areas is on non-productive or marginal forest lands.

Only a very small percentage of the leases is being actively developed. Out of a total of 740 square miles, it is estimated that only about 4 square miles of surface are currently disturbed by open pits or other mining operations. An additional acreage, much larger but unknown, has been cleared of vegetation during coal explorations. Much of this will revegetate naturally, but examples of serious erosion preventing re-vegetation are not uncommon.

Timber Harvesting

Timber harvesting is by far the most dominant land use in the project area. Seventy-two percent of the 13,400 square mile project area is committed to timber harvesting under Forest Management Agreement Areas.

Within the region of the project area, the forest industry is also the largest employer. Employment in timber-related industries, and service to that industry, probably accounts for the income sources of 3,500 of the estimated 4,700 population of Hinton. Employment in Hinton has been relatively constant from the timber harvesting component of the economy because North Western Pulp and Power operates year round. Similar effects will be felt in Grande Prairie with the growth of the Procter & Gamble operation.

Sawlog harvesting operations within the project area are active in the woods mainly during the period from freeze-up to break-up.

The presence of seasonal employment in the forest industry will diminish as the proportion of year-round harvesting increases.

Table 2.6 shows the approximate economic contribution of regional forest industries at present. This will increase substantially when the Procter & Gamble pulp mill reaches full production. Table 2.6 also indicates that the forest industry in the project area annually produces goods valued at $77 million at source. It employs 2,670 men and women directly. It maintains assets valued at $170 million. It generates Crown stumpage revenues approaching $3 million. Its contribution through taxation to municipal and more senior governments is not readily calculated but is substantial. The effect of any major curtailment in operations of this industry would be felt immediately and significantly throughout the region.

TABLE 2.6

MEASURES OF THE ECONOMIC IMPORTANCE OF REGIONAL FOREST INDUSTRY

(a) Volume and Value of 1973-74 Cut

	Volume		Unit Price f.o.b. Plant $	Sales Value $ MM
	Cut (M cunits)	Production		
Pulp and Paper	550,000	330,000 T	175/T	57.8
Lumber, plywood and minor products	240,000	145 MM B.M.	130/M B.M.	18.9
TOTAL	790,000	-	-	76.7

(b) Direct Employment (1973-74)

Woods	1,040 employees
Pulp manufacturing	1,050
Lumber and plywood manufacturing	580
	2,670 employees

(c) Value of Physical Assets (1973-74)

Woods	$ 24.00 MM
Pulp manufacturing	125.00 MM
Lumber and plywood manufacturing	20.00 MM
	$169.00 MM

(d) Crown Stumpage Revenue (1973-74)

Pulpwood:	550M cunits @ $1.30 -	$ 715 M
Veneer and Sawlogs:	240M cunits @ $9.50 -	$2,280 M
		$2,995 M

Transportation

With the exception of traditional in-community service industry, the other significantly identifiable industrial component in the project area is the transportation industry. This industry has two components. The first is the transportation service industry located along and catering to the Yellowhead route traffic. The other component includes: coal transportation via railways, oil pipeline systems, and the road building and construction industry supportive to the three major extractive industries.

Agriculture

For climatic and edaphic reasons, there is very little farming done in the project area. Mixed farming and grazing occur along the Wapiti River with marginal success. It is not expected that agricultural activity will increase from its minor role.

Tourism

Tourism, which has been defined as travelling for recreation is concentrated upon Highway 16 which intersects the lower portion of the project area. This highway is part of the Yellowhead route that links the Prairies with the Pacific Coast. Jasper, Alberta, which is the service and administrative center of Jasper National Park is located some 50 miles southwest of Hinton along Highway 16.

The proximity of Jasper National Park and total distance to Edmonton tend to inhibit the development of tourist-related industries within the project area.

The services presently afforded the tourist, who usually traverses the area in summer, are largely in the form of public camp grounds.

The present trends indicate that the tourist service industry will expand substantially in response to the need for services not provided in sufficient quantity in Jasper National Park, and in response to the overall increase in travel for recreation.

There is also a limited amount of tourist travel along the Grande Cache Highway, the Alberta Forestry Trunk Road and the "Coal Branch" or Highway 47.

2.10.3 Trapping

The beaver is the most important fur bearing mammal trapped in the project area, accounting for nearly one-half of the estimated 1972 harvest value of approximately $90,000. This revenue is derived from 212 trap lines in the project area and represents 3.3 percent of the total Alberta trapping revenue.

In addition to beaver, lynx is important in deciduous and mixed forests in the Grande Prairie district. Squirrel is more prevalent in the Hinton and Edson districts which have a greater proportion of coniferous forests. Other important fur bearers in the project area are coyote, muskrat, mink, and marten. Appendix II-8 summarizes recent levels of activity.

Trapping in the project area as well as in the rest of Alberta, is an uncertain economic venture. The number of pelts taken in 1971 was 12.3 percent less than the number of pelts taken in 1972; however, the total Alberta revenue for pelts increased over 100 percent over the same period. This tremendous price increase reflected the recovery from previous years when fur prices were low. It is suspected that, as in other areas of Alberta, trapping is simply a cash supplement to subsistence incomes. Trapping in the project area is not expected to increase in significance and will probably decline in line with the overall Canadian trend.

2.10.4 Hunting

The Fish and Wildlife Division of the Department of Lands and Forests issues licences for hunting in the project area for mule deer, white tail deer, moose, elk, mountain sheep, woodland caribou, black bear and grizzly bear.

It is not possible to obtain direct information on hunting returns from the project area. Estimates of hunter use and harvest of certain big game species in the project area have been extrapolated from information received by questioning hunters regarding the 1968 and 1969 hunting seasons in Alberta (Miller, 1971)

Approximately 10 percent of hunter days in the province in 1968 and 1969 were spent in the project area. Although bird hunting and big game hunting were not separated in the study, the major hunting in the project area is for big game. Figures of the moose, elk, and deer harvest in the project area indicate that both moose and elk hunting are excellent in this region. Approximately 20 percent of the Alberta harvest of these animals comes from the project area. Mule deer hunting appears to be good, although not as heavily practised or as successful as moose and elk hunting. White tail deer occur sporadically throughout the region, so kills are light. Figures are not available for other big game animals such as sheep and bear or for upland game birds.

As with all forms of outdoor recreation, hunting has increased tremendously over the last decade and the trend is expected to persist. Relative to any increase in the Alberta population of 22 percent between the decade 1961 and 1971, game license sales increased 64 percent. For Alberta, hunting licenses in 1971-72 reached 250,000 with corresponding Crown revenues at $1.4 million. No information is available on the rate of increase in hunting activities or success within the project area specifically.

Based on an estimate of the daily expenditure per hunter of $21.50[1], it is estimated that Alberta hunters, on an average over 1968-69, spent $2,200,000 in the project area on transportation, guns, ammunition and equipment, food, alcohol, lodgings, miscellaneous expenditure such as meat processing, packing, and license fees.

2.10.5 Guiding and Outfitting

Alberta game regulations require that non-residents and tourists be accompanied by a licensed guide in the major part of the project area. There are a number of registered guides and outfitters. Literature suggests that few guides depend entirely upon guiding as a source of income, working instead on a probable average of about 60 days per year on guiding and related work in the autumn. Other sources of income are mostly ranching, trapping, and logging.

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[1] "The value of resident hunting in British Columbia, Report No. 6, on the Economics of Wildlife and Recreation, British Columbia Fish and Wildlife Branch, 1972."

2.10.6 Fishing

Sport fishing is a popular form of outdoor recreation in the project area, particularly in the Athabasca drainage basin, and all indications are that it will increase in popularity along with other forms of outdoor recreation.

Native fish occupy many streams and lakes. Moreover, to enhance angling in the project area, the following lakes have been stocked: Nose Lake, Two Lakes, Pierre Grey Lakes, Grande Cache Lake, Victor Lake, Emerson Lake, Millar's Lake, Obed Lake, Graveyard Lake, Cache Lake, Kinky Lake, and Wild Horse Lake No. 1.

2.10.7 Outdoor Recreation

The Importance of Outdoor Recreation

Outdoor recreation provides a contact with nature which can restore man's body and soul. This contact is increasingly important in the fast-paced technological world of today.

Outdoor recreation is generally regarded as a public good. As a result provision of adequate facilities for public use is considered to be primarily the responsibility of government. These facilities, made possible through public funds, are normally available at minimal or no cost to the user.

Tourism and recreation are now considered an important land use and a major economic activity in comparable areas in the United States. For example, Roosevelt National Forest in Colorado is now managed primarily for its value as a forest recreation area rather than for timber production, as was the case in previous decades. In the long run the same situation could develop in portions of the project area.

The Economic Value of Recreation in Alberta

Tourism is an important industry in Alberta. Many tourists and Alberta residents seek various outdoor recreational activities, making outdoor recreation an important land use in the Province. The economic value of tourism was suggested by the Department of the Environment of Canada, in a report entitled "Land Use and Resource Development in the East Slopes of Alberta", July 1973. This report states that expenditures by tourists in Alberta in 1972 exceeded $300,000,000.

The Increasing Demand for Outdoor Recreation

The increasing demand for outdoor recreation is a function of several factors, namely:

- a growing population;
- an increasingly urban population;
- increased mobility of the population;
- increased leisure time;
- an increasing percentage of family income being allocated for recreational use;

- a diversification of recreational demands;
- tourism as a form of recreation, or of
- reaching recreational areas.

There is a growing population in Canada as well as a westward shifting of the population center of the nation. With this double-spurred population increase in Western Canada, Alberta's prime recreation resources will be more and more sought in the future.

The Range of Recreational Demands

Outdoor recreation may be intensive or extensive in terms of land use. Intensive recreation activities require well developed facilities concentrated in a small area. Examples of intensive recreation include golf, boating (Marinas), vehicle park campsites, and downhill skiing. Extensive recreation requires few facilities, and participants are dispersed throughout the areas of use. Hiking, stream fishing, and photography are examples of extensive recreation.

Coupled with the desire for outdoor recreation is an increased demand for protection of the historical, archaeological, and natural environment.

The Project Area as a Recreation Area

Alberta's Eastern slope offers a greater variety of recreational opportunities than other parts of the Province. Within the project area, the greater visual variety available in the western portion makes this part significantly more appealing to the recreation seeker than the flatter, less varied landscape of the eastern portion. Also Jasper National Park and Willmore Wilderness Provincial Park abut the southwest border of the project area. The western portion, being in close proximity to the Mountain Parks, will be increasingly used for "spill-over" recreational purposes and as a buffer zone between commercial forest land and park territory.

Inventory of Recreational Resources of the Project Area

The project area has, in general, a good capability for extensive recreation such as hiking, hunting, whitewater canoeing, fishing, and observation and photographing of wildlife and landscapes. Limited resources exist for intensive recreation such as swimming, boating, water skiing and cottaging.

Areas of acknowledged recreational value within Alberta Forest Service jurisdiction are termed Forest Recreation Areas. These are relatively small acreages set up for intensive visitor uses, such as camping, picnicking and water-related activities. Forest Recreation Areas are complementary to highway campsites maintained by the Highways Department, and provincial parks maintained by the Provincial Park Administration.

Existing facilities include:

Existing Forest Recreation Areas by Class, Location, and Number of Camping Units (May 30, 1973)

Class I Recreation Areas: Those developed in accordance with approved plans. Areas include separate picnic, tent and trailer sections and able or planned to accommodate 25 or more camping units. Water source developed. May be subject to further expansion and may lack one of the three planned sections.

Recreation Area	Class	Forest District
Big Berland	I	Edson Forest
Cardinal River	I	Edson Forest
Emerson Lakes	I	Edson Forest
Fickle Lake	I	Edson Forest
Forks	I	Edson Forest
McLeod River	I	Edson Forest
Pierre Grey	I	Edson Forest
Rock Lake	I	Edson Forest
Two Lakes	I	Grande Prairie Forest

Class II Recreation Areas: Those partially developed without separate sections or individual units but with sufficient facilities to accommodate 10 family units simultaneously; or fully developed areas (as in Class I) but having facilities to accommodate less than 25 camping units. Must have drilled well.

Recreation Area	Class	Forest District
Fairfax Lake	II	Edson Forest
Simonette Rive	II	Grande Prairie Forest
Whitehorse Creek	II	Edson Forest
Wildhorse Lake	II	Edson Forest

Class III Recreation Areas: Partially developed areas (as in Class II) of less than 10 family unit capacity, group camps which are generally available on a reservation basis to organized groups, and day use areas such as viewpoints and areas designated for picnicking only.

Recreation Area	Class	Forest District
Coal Valley	III	Edson Forest
Cutbank River	III	Grande Prairie Forest
Economy Lake	III	Grande Prairie Forest
Hay River	III	Edson Forest
Kinky Lake	III	Edson Forest
Nose Creek	III	Grande Prairie Forest
Pinto Creek	III	Grande Prairie Forest
Shuttler Flats	III	Grande Prairie Forest
Westview	III	Grande Prairie Forest

Shuttler Flats Campground is another recreational resource of the project area. This campground is used mainly by hunters in the autumn. The site is used occasionally by picnickers and overnight campers.

Recreational Resources and Facilities in Relation to Present Demand

In general, the recreational resources of the project area have not been developed to maximum advantage. Present facilities do not adequately meet the demands placed upon them. Planning for the development of recreational facilities is dispersed among several government agencies as both the Alberta Forest Service and the Alberta Parks Branch have forestland recreation management responsibilities. The Alberta Forest Service makes regulations governing use of Forest Recreation Areas. Serious deficiencies exist in forest recreation management practices and policies of the Alberta Forest Service, in the face of a rapidly growing demand for diversified forest recreation opportunities. The programs of the various agencies tend to reflect personal value judgements in recreation management policies and programs. An integrated, full-ranging program is therefore lacking.

In this respect the Alberta Forest Service budget allocation for recreational uses would seem to be inadequate. While the budget is only slightly increased from the level of 7 years ago (1966-67), recreational demand is growing at the rate of 10 percent per year.

The desires and expectations of recreation seekers using the project area have not been fully investigated. This lack of knowledge frustrates proper planning for adequate facilities to satisfy the wide (and unknown) range of recreational demands.

Part of the project area is included in the Peace River Regional District. The Peace River Regional Planning Commission, in 1972, conducted a survey to determine the recreational wants of persons in pursuit of the area's recreational opportunities.

Some of the findings of the survey were:

1. A higher percentage of the residents of the area surveyed own equipment such as snowmobiles, boats, canoes, and camping vehicles than does the population of Canada as a whole.

2. Picnicking, sightseeing, and recreational travel are the most common outdoor recreation activities of residents of the Peace River Region. An extensive network of fairly good roads makes much of the area accessible for these pursuits.

3. Other outdoor activities participated in by relatively large percentages of the group surveyed included:

- visiting historic sites;
- fishing;
- swimming;
- hiking;
- bicycling;
- tobogganing;
- tent and trailer camping;
- hunting;
- horseback riding;
- viewing and photographing wildlife, plantlife, landscapes;
- rockhunting;
- golfing;
- motorcycling;
- downhill and crosscountry skiing;
- sailing;
- skin and scuba diving.

4. The absence of convenient facilities accounted for non-participation in 22 outdoor activities.

5. Water-oriented activities are much desired, but few resources exist to satisfy this demand in the project area.

6. A preference for natural rather than man-made characteristics was noted.

7. The ideal outdoor recreation area seems to be imagined as a body of water, with treed banks and a beach, all in a more or less natural state.

8. Various specialized facilities are desired by some users, and if available, would make the area more attractive to these users.

9. Slightly more than half the people surveyed favored developed recreation facilities. The remainder favored areas protected from competing resource uses which would tend to decrease the recreational value of the area.

Kakwa Falls, Wapiti Valley, and the Two Lakes area were indicated as areas which should be left in a natural state, or protected from land uses incompatible with recreation.

10. About one-quarter of the surveyed group preferred "partial access", while about 20 percent ranked "high grade roads" last.

2.11 Cultural Factors

2.11.1 Archaeological and Historical Values

Historical and archaeological resources constitute one of the most valued and yet most fragile assets of any region. From the evaluation of such resources, the past may be reconstructed to give present and future generations a concept and an appreciation of the cultural heritage and background of the region. Protection of features of historical and archaeological significance is made difficult by the fact that they may be unknown, unrecognized, buried, lost, burned, vandalized or destroyed by man's activities.

Prehistoric Occupation

The first humans are believed to have reached North America from Asia approximately 20,000 years ago. The main migration route of these people was southward by land through Alaska, Yukon and Alberta.

There is recent evidence that portions of the Alberta Foothills, including the project area, escaped glaciation at the time of the Classical Wisconsin Glaciers of 12,000 - 24,000 years ago. An ice-free corridor would thus have existed at the time of the migration of Asian peoples into North America. The ancestors of most natives in North and South America may have passed through the project area.

A known archaeological site is defined as any location where evidence has been found of prehistoric human occupation. A reconnaissance survey conducted by the University of Alberta in the mid 1960's, defined about 25 archaeological sites, one of which yielded a fluted projectile point believed to be at least 9,000 years old. It is estimated that many archaeological sites, as defined above, may ultimately be found in the project area, some dating back 16,000 to 20,000 years.

Early sites will probably be found on river terraces 100 feet or more above present river levels. More recent occupation will likely be found progressively closer to the present lower river levels. Few important sites will be located beyond the river valleys.

A small cultivated flat exists on the north side of Maskuta Creek, evidence that at least one group of prehistoric residents practised a primitive form of agriculture. However, hunting, fishing, and gathering were the main means of obtaining a livelihood for virtually all prehistoric peoples sojourning in the area. A site near the confluence of Mumm Creek and Wildhay River is believed to have been used by the Indians as a "buffalo jump". The site may have been used as late as 1860.

Historic Human Occupation

Towns, villages, rivers and lakes in the project area bear French names attesting the fact that French voyageurs and trappers were the first white people to visit this part of North America. Only sketchy historical records exist concerning Indian and Metis groups in the project area in the 19th Century. For example, a number of graves have been documented on several sites. These graves, totalling 44 in all, were all constructed in fairly recent times. Grave sites occur at Shuttler Flats, Sherman Meadows (one believed to date from 1894), Nose Mountain, Round Prairie, Porcupine Cabin, and at Buffalo Head Camp. The last mentioned grave site dates from 1896.

A chronological list of events relating to the history of the project area follows:

1793 - David Thompson first explored the area for the North West Company.

1810 - Thompson encountered the Athabasca River near Hinton, and following it to its source, discovered the Athabasca Pass and the Canoe River. This route was used regularly by travellers until the coming of the Canadian Pacific Railway in 1885.

1813 The original Jasper House was built on the north end of Brule Lake.

1820 - Ignace Giasson and Tete Jaune (Yellowhead) explored a route from Hinton to the Grande Prairie area. This route is believed to be essentially that taken today by the Alberta Resource Railway. Ignace Giasson was fur trader for the Hudson Bay Company. The exact identity of Tete Jaune is unknown.

Grande Cache is the site of an Indian

settlement where Ignace Giasson cached the season's "take" of furs rather than risk their loss in the Smoky River, which on that occasion he found too hazardous.

1821 - The Hudson's Bay Company and the North West Company united.

1824 - Governor Sir George Simpson mentioned deposits of coal appearing at Brule Lake.

1826 - David Thompson discovered the Yellowhead Pass.

1829 - The original Jasper House was abandoned and the second Jasper House was built close to the site of present-day Jasper. This establishment served travellers using the Yellowhead and Athabasca passes.

1862 - Gold seekers known as the Overlanders used the Yellowhead Pass on their way to the British Columbia gold fields.

A few years later smallpox-stricken Indians from Jasper stopped at Hinton and several of their number died here while the stronger pressed on to Lac St. Anne Mission for help. The Indians thereafter referred to Hinton as the Smallpox Camp.

1872 - The Athabasca, the Yellowhead, the Howse and Peace Passes were surveyed for possible railway routes through the Rocky Mountains.

1891 - Settlement was first recorded in the Grande Prairie area, followed by some early sawmilling. Homesteading along the proposed route of the railway from Edson west to Hinton continued to increase in this period.

1895 - John Gregg, a retired U.S. Army Scout, settled at Prairie Creek, west of Hinton. Both his name and that of his wife Mary Cardinal, are preserved in the names of local lakes and creeks.

1907 - The land comprising Jasper National Park was dedicated for park use.

1910-1911 - The railway reached Edson. Settlers of Grande Prairie constructed a trail to Edson via Sturgeon Lake. This trail was 250 miles long and used primarily in winter until 1916. Construction on this trail must have been a major undertaking.

World War I - The Canadian Northern Railway and the Grand Trunk Pacific Railway went bankrupt. Both were taken over by the Federal Government. Parts of each railway line were utilized. New track was laid to the Brule coal mines on the west side of Brule Lake. Entrance became a ghost town and Dyke Station was renamed "Entrance". The original Entrance was the last station before the railway entered Jasper National Park.

2.11.2 Wilderness Values

National and Provincial Parks adjacent to the project area provide opportunities for the "wilderness experience" in zones set aside for limited and nonmechanized access.

Jasper National Park and the Provincial Willmore Wilderness Park abut most of the west side of the project area. There are no wilderness area designations within the project area although the Alberta Wilderness Association has requested that a 38 square mile region near Folding Mountain be designated a Wildlands Recreation Preservation. This area has no forestry commitments associated with it and will likely be afforded some sort of park status.

The close location of Jasper and Willmore probably satisfies the requirement for pure wilderness experience, although it must be recognized that within the area of outdoor recreation there exists a demand for more primitive recreational sites left in a quasi-wilderness state. Within the project area there are areas that, by various definitions, could be classed as "wilderness" because of their undeveloped or unexploited state. For this project, requirements for primitive outdoor recreation areas for extensive recreational pursuits have not been interpreted as a demand for Wilderness Areas.

2.11.3 Scenic Values

Concern with the scenic values of the land and their relationship to the broader resource issues is a recent development.

The assessment of visual quality is a subjective matter but there is little doubt that portions of the project area exhibit visual qualities which appeal to a broad range of people.

Inventory of Visual Characteristics

The Visual Quality map in Volume 2 is a zonal map which identifies areas of uniform landscape based on landform, vegetation, and surface water features. The map rates visual quality of the area by a shading system of dark to light, dark areas being the highest visual quality zone.

Specific areas of high interest have been noted on the map by an asterisk. These are areas of high visual quality, historic interest, or recreational value. These designated areas are based on personal site observations and consultation with public and private authorities. Undoubtedly more public interest areas will be uncovered in the future and all will need special on-site evaluation.

The Visual Quality Overlay in Volume 2 is derived from evaluation of local combinations of land forms based on the following premises:

- The greater the topographic relief the higher the visual quality.
- The greater the local diversity the higher the visual quality.

Subject always to points of interest and to established road access patterns, the five Visual Quality Zones recognized in mapping in ascending order, are:

- Plateau Area - Visual Quality Zone Five

  This gently rolling to flat land of mixed woods has the lowest rated visual quality of the project area. Views in the plateau area are mainly straight-ahead views limited by forest edge along roads. Occasional grazing or clear areas allow an expanded view of a flat plain and a visible horizon line; however, no middleground views are generally observed. Occasionally the land is gently sloping or rolling, but in general, all views are long distance views. Height of viewer's position in the landscape remains unchanged in the plateau area and therefore there is little diversity or surprise in the landscape.

  In certain areas, views are enhanced by a variety of tree stands.

- Low and Medium Foothills Area - Visual Quality Zones Three and Four

The lower and medium foothills are characterized by gently rolling land which allows outward views from the roads and permits changes of height of the viewer in the landscape. These elevational changes heighten the viewer's interest. Ridge lines of higher foothills are visible to the viewer as well as high peaks within the foothills and mountain areas. A variety of views incorporating foreground, middleground and background views are inherent to the area, but are less dramatic than the upper foothills or mountain views.

- High Foothills Area - Visual Quality Zone Two

Views from access roads in the upper foothills are characterized by a variety of position changes for the viewer either on top of ridges or below in valleys. Most views are open views with a background of the Rocky Mountains as well as foreground and middleground views. Lakes and rivers are an important integral part of the total view. Tree growth is mainly spruce and does not contribute interesting contrasts or diversity in foreground or background viewing.

- Mountain Area - Visual Quality Zone One

The mountain views and their inherent diversity are extremely challenging to the viewer. Views are a composite of a number of variations in land forms and land patterns such as snow peaked mountains, alpine slopes, steep forested hillsides, moderate forested slopes, mixed wood, monolithic stands of spruce, rivers, and lakes. These resolve in a variety of viewing patterns made up of a sequencing of foreground, middleground and background views. The element of the unexpected is a constant characteristic of the mountain landscape.

Superimposed on these landscape views are foreground views of mining sites both active and abandoned, recreation sites, timber harvesting areas, and urban road edge developments as seen in Hinton and Grande Cache.

High Quality View Areas

1. Some of the areas of highest quality viewing include Kakwa Falls, Rock Lake, and Mountain Park. These areas have superb views of the Canadian Rocky Mountains and middleground views of meadows, valleys, lakes and rivers. Foreground views are also diverse and include a variety of plant material from lake-edge plant growth to sub-alpine meadow vegetation of special interest.

2. Kakwa Falls is a visual feature of exceptional quality. Throughout the entire study site there is not a single feature of comparable quality. The entire region surrounding the falls should be looked at in relation to recreational use.

3. Two Lakes is a very high quality viewing area and there are great demands on this area for recreation purposes such as fishing, camping, and boating. The area is contained by steep hillsides which form part of the edge of the lake. Vegetation varies from dense stands of spruce to open mixedwoods. Edge quality varies from open foreground views over grasses to veiled foreground views through spruce. Reflective quality of the water adds another dimension to foreground and middleground views. Along

the lake edges, natural plant communites have developed and are extremely sensitive.

4. Mountain peaks such as Nose Mountain provide dramatic and visually high quality viewing. From Nose Mountain the viewer has a dramatic panoramic view of the Canadian Rocky Mountains with an extensive middle view of the foothills. The view is not compromised by roads or clearcut areas.

5. A number of smaller lakes as well as several larger ones are scattered between an area from Hinton to Grande Cache. Some of these are interconnected making them interesting for boating, canoeing, and fishing.

   The lakes are generally small with interesting edge vegetations of grasses, spruce and mixed wood. Some lakes are in open areas with interesting foreground views of birch, middleground views of mountains. Most lakes in this area because of size, vegetation patterns, and land forms, foster a mood of contemplation, restfulness, and quietude.

6. Chinook Ridge and the Forestry Trunk Road have high quality viewing provided by the height of land. Extensive distances may be viewed, from Canadian Rocky Mountains in the far distances to extensive middle and foreground views of the foothills. Mixed wood areas provide a diversity for quality viewing. Many other ridge lines and valleys are viewed as an ever diminishing series of lines which heighten the viewing quality.

7. Aeolian Deposits

   The sand dunes to the south of Grande Prairie were derived from lacustrine sand. These dunes have been stabilized by vegetation. In most cases the lowland between the dunes is covered with muskeg and sedge bogs while the dunes support mainly jackpine. The outline of the dunes are emphasized by vegetation changes.

8. Limestone Caves

Located four miles north of Cadomin, these limestone caves are excellent for underground climbing or spelunking. Although not commercially developed these caves are known to be extensive.

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CHAPTER II

PHOTOGRAPHS

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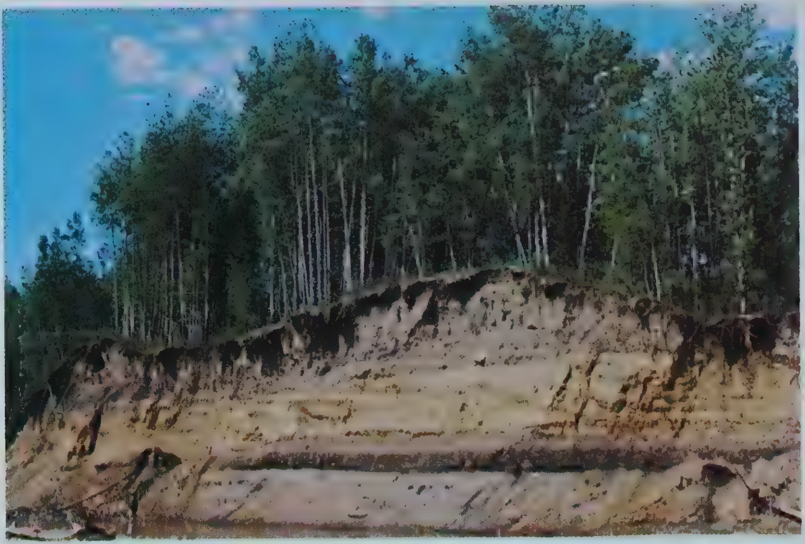

Photo 2.1 Northern streams are actively downcutting. Aeolian soil and ablation till overlying sandstone and coal seams - Pinto Creek at Nose Mountain Road.

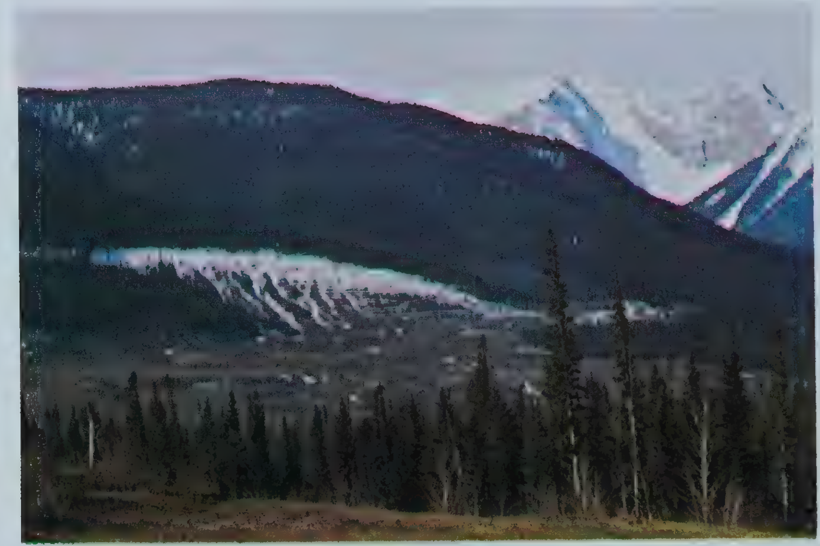

Photo 2.2 This tractor skidding operation (Terris Mill, Hinton) was completed in 1972. Terrain is steep but soil is relatively stable (cordilleran and mixed till). Erosion is not yet significant, but may become so if revegetation is delayed.

Photo 2.3 The silt-laden Cutbank River is typical of northern rivers with banks not yet stabilized.

Photo 2.4 Natural gravel deposited at Mumm Creek flood plain. AFS excavations may have contributed to instability.

Photo 2.5 Presence of aspen stands in mixture with spruce stands will help assure that coniferous harvesting does not seriously affect existing watershed or habitat values. (M.U. G4)

Photo 2.6 This 160-year-old pine stand in M.U. G7 (Kakwa River) contains over 40 C C.F. per acre, almost entirely of sawtimber size.

Photo 2.7 Predators and this mule deer are at home on cutover lands. (G7-LI)

Photo 2.8 The Upper Wildhay River, upstream from the Grande Cache Highway, is an example of good sport fishing potential.

Photo 2.9 Some merchantable timber stands occur on agricultural land south of the Wapiti River.

Photo 2.10 This natural gas processing plant is in the Gold Creek Gas Field (M.U. G5). It is adjacent to the Alberta Resources Railroad.

Photo 2.11 Rock Lake, on the Upper Wildhay, is at the eastern entry point for the Willmore Wilderness Park.

Photo 2.12 Emerson Lake Campsite.

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CHAPTER III

3.0 DESCRIPTION AND ANALYSIS OF FORESTRY ACTIVITIES

Timber harvesting and associated activities have a potential for modification of the environment. The nature of these operations needs to be understood before this potential can be intelligently assessed.

3.1 Forest Management and Administration

3.1.1 Objectives of Public Forest Management

Forest lands in Alberta are largely owned by the Crown. Government policy is to use Crown forests for the support of permanent forest products industries in order to realize reasonable revenues and to promote stability of employment and community life. Along with this primary use come obligations to protect the forests from damage, and to maintain their productivity. There is also an obligation to give full consideration to other direct users of forest land, with growing emphasis on temporary, non-commercial, or indirect uses like watershed protection. Withdrawal of areas from regulated cutting may take place on a limited scale, but cannot interfere fundamentally with Crown commitments for annual cutting of specified volumes.

The project area makes an important contribution to fulfillment of this Provincial objective.

3.1.2 Government Regulation of Forests

Forest management is implemented and regulated by legislation as follows:

1. The Forests Act (1971) This Act provides for appointment of Forest Officers, and outlines the powers of the Lieutenant Governor in Council and of the Minister of Lands and Forests to regulate forest tenures, forest management, and the processing of timber products. The 1971 Act contains revisions emphasizing sustained yield forest management.

2. The Public Lands Act (1971) This Act pertains largely to the administration of non-forest lands, but does make provision for:

   - classification of public lands for appropriate uses (the "Green Area" was thus created and exempted from alienation or settlement);

   - cutting of homestead and right-of-way timber under stated conditions for protection of the environment;

   - control of allocations of public lands for development, recreational, or other special uses;

   - protection of beds and shores of watercourses and lakes.

3. The Forest and Prairie Protection Act (1971) This Act provides for protection from fire, industrial pollution, and forest pests. Government powers to prevent or control damage from these sources are detailed.

4. The Wildlife Act (1970) and Alberta Fisheries Act

This Act provides for regulation of trapping, hunting, and activities which might threaten game, bird or fish populations or habitat. While the Fish and Wildlife Division of the Department of Lands and Forests possesses goals, policies, and regional plans for sustained yield management of wildlife, it seems fair to observe that the Wildlife Act itself fails to emphasize these in its concern for the necessary but less positive aspects of prohibition, enforcement, and penalties. Alberta regulation of fish resources is at times complicated by overlapping federal regulation.

5. Land Surface Conservation and Reclamation Act (1973)

This new Act covers virtually all activities which materially disturb land surfaces (including construction or operation of wells, pipelines, transmission lines, mines, quarries, pits, geophysical lines, industrial sites, recreation sites, roads, railways, airstrips, and dams). It applies to Alberta government and specified "extra-territorial" developments as well as to private ones. The Act equips the Minister of the Environment with machinery and powers to:

- determine the environmental impact of proposed operations;
- restrict local damage by agreement, impose rules, purchase, exchange, or expropriate;
- control "Regulated Surface Operations" by means of approved plans, regulations, Stop Orders, and Surface Disturbance Control Orders (with heavy penalties for noncompliance);

- arrange for administrative assistance from the Departments, including Lands and Forests;
- provide for reclamation by the operator through reclamation deposits, orders, certificates, grants, loans or loan guarantees;
- provide for governmental reclamation of abandoned sites;
- provide for the correction of off-site surface damage and the penalizing of those responsible.

Powers to prevent, control or repair surface damage under this Act appear unlimited, except for the normal rights of appeal or arbitration, and the limitations of technology, administration, and economics.

6. The Forest Protection Regulations (1962)
These regulations under the Forest and Prairie Protection Act deal mainly with fire protection on forest lands, including woods travel, slash disposal, clearing, use of explosives, sawmilling, fire suppression, and general fire precautions. They also provide for control of AFS forestry roads.

7. The Timber Management Regulations (1973)
These regulations, issued under the powers of the Lieutenant Governor in Council, define in considerable detail the basis for such things as:

- administration of the Timber Quota System (Sections 3 - 36);
- administration of Commercial Timber Permits (Sections 37 - 48);

- administration of Local Timber Permits and Crown Christmas tree cutting (Sections 49 - 69);
- provisions for custom sawmilling (Sections 70 - 74);
- General Rates of Crown Dues (Sections 75 - 86);
- timber appraisal (Sections 87 - 90);
- payment of Crown charges (Sections 91 - 97);
- timber harvesting operations (Sections 98 - 111);
- records (Sections 112 - 116);
- transportation records (Sections 117 - 122);
- reforestation (Sections 123 - 145);
- clearing of land for industrial use (Sections 146 - 153);
- assignments (of cutting rights) (Sections 154 - 163);
- general provisions (Sections 164 - 170);
- penalties (Section 174).

8. The Timber Regulations (1973) These regulations, also under the Forests Act and issued under the powers of the Minister, cover:

- scaling licenses and permits (Sections 3 -10);
- general tariff of fees (for documents and other Crown services) (Section 11);
- forms used under the Act and under the Regulations (Section 12).

To the extent that legislation alone can be effective, the Alberta Acts and Regulations governing forests provide amply for effective administration.

3.1.3 Evolution of Forest Management

The Alberta Forest Service (AFS) was created in 1949. Its growth parallels that of many provincial forest services, but was compressed into fewer years. The first major preoccupation of the AFS was to build an organization capable of reducing wildfire losses to acceptable levels. A second important task was the identification of permanent forest lands and their subdivision into forests and Management Units of efficient size. The first forest inventories were completed only in the period 1949 - 1962, and sustained yield capacities were then assigned to each Management Unit. This was the first opportunity to determine, on a regional basis, the level of cutting which could be sustained in perpetuity, given reasonable fire protection and reasonably prompt regeneration. Refinements in sustained yield management systems and gradual increases in cutting to approach established allowable cuts are still taking place.

3.1.4 Forest Management Agreements

The first permanent commitment for sustained yield forest management by a company, and the first in support of pulp production rather than lumber or timber production, was the Forest Management Agreement with North Western Pulp and Paper Limited (NWPP), in September, 1954. This agreement, renewable indefinitely while its terms are kept, allots a specific area of forest land under lease to NWPP, for the practice of forest management to support pulp operations. It differs fundamentally from previous timber dispositions in committing successive crops rather than one crop to the company, and in its transfer of responsibility for local management of Crown forests to the company, under AFS supervision. In addition, stumpage payable is determined by periodic negotiation rather than competitively. The NWPP agreement appears to have become and remained the standard against which subsequent agreements and other tenures are measured.

A second Forest Management Agreement (FMA) was signed with North Canadian Forest Industries Limited (NCFI) in May, 1964. This was for the support of a permanent plywood and lumber complex at Grande Prairie. Apart from a small FMA area in the Peace River Forest (Dell Acres), the only other FMA to date in Alberta is that signed by the Procter & Gamble Company of Canada (PG) in January, 1969. This agreement was for support of a major pulp industry at Grande Prairie. Pulpwood cutting commenced in January, 1973 under this agreement and completion of mill construction is expected in the fall of 1973.

These three agreements are explicit, lengthy, and complex. An abbreviated comparative summary, with emphasis on those clauses relating to this study, is given in Appendix III-1. These agreements unquestionably create an excellent climate for the practice of sustained yield forestry.

Rights and responsibilities of each party are defined unambiguously, and provide a fixed standard against which results can be measured.

3.1.5 The Timber Quota System

The most recent forest tenure granting cutting rights on Crown lands is the Timber Quota System, initiated in 1966. This system was established to relieve established operators from the undesirable features of unrestricted bidding on Crown timber, and to increase their responsibility for planning, management, and the reestablishment of timber crops. The forest industry, represented by the Alberta Forest Products Association (AFPA) participated in and supported the development of this new system. Greater permanence, wider distribution of operations throughout remote areas, and several other advantages desired by all parties were made possible. The Alberta quota system is similar to the Timber Sale Harvesting License system operating in British Columbia. The quota system is also similar in many ways to the FMA but differs in the following respects:

- Cutting rights are "floating" within a given management unit. No specific area is leased to the operator permanently.

- Volumes committed tend to be smaller than those under FMA's, and are not necessarily granted to supply raw material for specific new installations.

- Original quotas were "earned", on the basis of previously established production needs. Subsequent quotas have been acquired competitively, through a lump-sum bid, but once acquired bear appraised stumpage rates, so that the quota holder is not subject to the risk of being outbid in future.

- The quota holder undertakes forest management commitments approaching those of the FMA holder, except that he can still elect to pay a reforestation charge ($2.00 per M B.M. cut) in lieu of assuming this responsibility and cost directly.

- As required for continuous production, the quota holder is periodically issued a new license of specified location and duration. Control of forest management and harvesting operations by the AFS is thus feasible, while the operator enjoys assurance of a continuous supply of timber from the management unit.

3.1.6 Temporary Cutting Tenures

Various dispositions granting cutting rights for Crown timber preceded FMA's and the quota system. Some of these remain in effect and many new ones are still being granted, generally where the timbered area is limited and cutting will be of short duration. These are all characterized by a specified area and period for completion of cutting. The common forms are:

- Unexpired licenses. These were granted before the quota system evolved and carry no direct reforestation obligation. NCFI retains unexpired licenses within the FMA of Procter & Gamble.

- Commercial Timber Permits and Competitive Sales. These are temporary cutting rights to specified stands, sold by auction or sealed tender (except in the case of salvage operations in development or research areas). The permittee must pay a reforestation levy of $2.00 per M B.M. of coniferous timber cut (or lesser rates as defined in the regulations).

- Local Timber Permits. These are of one year's duration and of low volume (maximum 180 M B.M. per year of live conifers). The permittee must be a local resident. Timber is sold non-competitively, at general rates of Crown dues. Custom milling is confined to timber originating from Local Timber Permits or private lands.

> Cutting is under AFS supervision. Responsibility for reforestation is borne by the Forest Service, not the permittee, but the permittee must pay a reforestation levy of $1.00 per M B.M. cut in excess of 30 M B.M.

These temporary tenures cover a relatively unimportant segment of the forests of the project area. Compared to the larger quota and FMA operations, they require disproportionately heavy administrative attention by the Forest Service. They reportedly tend to restock naturally, however, and are generally too small and scattered to impose serious environmental problems.

3.1.7 Forest Inventory Statistics

The most recent forest inventory maps and field surveys for the entire project area were prepared between 1951 and 1963. Two recent AFS summaries were used to determine current forest acreages and volumes. The first, a series of computerized Unit Summaries completed in April, 1973 by the Timber Management Branch, was used as the definitive source of all acreages. Table 3.1 (Estimated Acreages by Age Class) was prepared from analysis of these unit summaries, after appropriate deletions of areas outside the project area. The second, a special May 1973 compilation from the same source, provided volume estimates updated from the date of inventory, but these were not segregated by age class nor accompanied by corresponding acreages. Table 3.2 (Estimated Inventory Volumes) is based largely on this compilation. The final line of Table 3.2 indicates the best estimate of coniferous volume present in all mature and overmature stands. Unlike the preceding tabulations, it is derived from the same data as Table 3.1 The mature volume, 2,858 million cubic feet, is subject to both upward and downward corrections, but basically indicates a 20-year supply if harvesting rose to and was maintained at the unattained total allowable cut specified for the

TABLE 3.1

ESTIMATED ACREAGES BY AGE CLASS (CONIFEROUS AND DECIDUOUS TYPES COMBINED)

Age Class	TENURE									
	PG FMA		NCFI FMA		NWPP FMA		CROWN		TOTAL	
	M Acres	%	M Acres	%	M Acres	%	M Acres	%	M Acres	%
Regeneration	62	2.0	5	0.9	18	0.9	64	2.1	149	1.7
Young Immature	445	14.6	87	15.3	307	15.6	676	22.5	1515	17.6
Immature	1041	34.0	155	27.4	901	45.8	1051	35.0	3148	36.6
Mature Overmature	730	23.9	160	28.4	351	17.9	318	10.6	1559	18.2
TOTAL FORESTED	2278	74.5	407	72.0	1577	80.2	2109	70.2	6371	74.1
Potentially Productive	332	10.9	104	18.3	81	4.1	120	4.0	637	7.4
Nonproductive	448	14.6	55	9.7	308	15.7	777	25.8	1588	18.5
TOTAL LAND	3058	100.0	566	100.0	1966	100.0	3006	100.0	8596	100.0
Equivalent, square miles	4778		884		3072		4697		13,431	

Source: Alberta Forest Service, April, 1973. Unit and Partial Unit Summaries for Project Area. Acreages are updated for fires since inventory date, but not for cutting.

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TABLE 3.2

ESTIMATED INVENTORY VOLUMES
(M C.F., TREES 4 INCHES AND OVER)

	TENURE				
	PG FMA	NCFI FMA	NWPP FMA	Crown	Total
Total 1973 Growing Stock All Age Classes:					
Conifers	2,754,000	433,000	2,462,000	3,509,000	9,158,000
Deciduous	1,572,000	369,000	426,000	731,000	3,098,000
ALL SPP.	4,326,000	802,000	2,888,000	4,240,000	12,256,000
Average M C.F./Acre	(1.90)	(1.97)	(1.83)	(2.01)	(1.95)
Mature and Overmature:					
Coniferous Only	1,203,000	295,000	699,000	658,000	2,858,000
Conifers M C.F./Acre	1.65	1.83	1.99	2.07	1.83

area. Under existing commitments, presently mature stands would remain uncut for longer, perhaps 30 years.

Inventory data for portions of the project area are available from two of the FMA holders, NWPP and NCFI. These data are more recent and detailed than the AFS data, but indicate nothing concerning the PG Agreement Area or the extensive Crown lands of the area. Omissions and differences in definitions make comparisons difficult, but these FMA inventories cast some doubt on the reliability of the AFS inventory data for corresponding areas. The AFS data are from one to two decades old, and have undergone artificial manipulations during updating. The AFS age classifications, of importance in assessing acreages available for imminent clearcutting are largely inferred from height codes, rather than determined from field age counts. The AFS acreages are adjusted for post-inventory fires and industrial clearing, but not for the considerable acreages of post-inventory harvesting done in parts of the area. An AFS program to establish records for every cut block in Alberta is underway, but results are unavailable.

Based on independent field observations, the best evaluation of the AFS inventory that can be made for the project area is that:

1. Total and productive acreages are reliable, subject to any future withdrawals for special land uses.

2. Per-acre volumes are realistic in comparison with field spot-checks. Total growing stock estimates thus appear realistic or conservative.

3. The age class distributions in Table 3.1 probably underestimate true acreages of mature and overmature, and correspondingly overestimate acreages of the younger age classes. Separate distributions for coniferous stands alone and for coniferous stands over 80 years of age (corresponding to the pulpwood rotation age) would be useful, but are not available.

Extensive forest inventories frequently prove conservative in relation to subsequent intensified inventories. This general observation is believed to apply to the AFS inventory data procured. It can thus be stated in general that the project area supports acreages and volumes no less than those shown in Tables 3.1 and 3.2. As is demonstrated in the following section, the true inventory volume for the entire project area will not become critical until the level of annual harvesting increases substantially.

3.1.8 Allowable Cut, Committed Cut, and Current Cut

Harvesting of a small proportion of total acreage each year obviously would disturb a forest less than harvesting of a larger proportion. Early cutting operations on the project area were small in scale. These had little broad environmental effect, but failed to utilize forest productivity. Overly rapid cutting on the other hand would devastate and impoverish the land, and lead to eventual timber famine. The course which government and industry have elected is unlike either of these. It is aimed at utilization of timber at a rate which can be sustained perpetually. Maximum cutting rates are established for each management unit to accomplish this. The question whether these rates are sustainable without impairment must be examined.

The relationships between the project area's sustained yield capacity, committed harvesting, and current harvesting are outlined in Table 3.3. Timber Management Branch data prepared in August, 1972, are used as the source of this table. Minor additions and deletions in commitments are taking place but they do not significantly affect this picture. A minor portion of the cut committed to Procter & Gamble can be obtained from Management Unit G1, outside the study area. Similarly the FMA timber of NCFI is currently drawn from the

TABLE 3.3

RELATIONSHIP BETWEEN TIMBER SUPPLY, COMMITMENT AND DEMAND ON PROJECT AREA

Forest	Edson	Grande Prairie	White-Court	Total Study Area
Coniferous Volume, MM C.F.*				
Net A.A.C.	84	55	9	148
Committed (FMA or QUOTA)	33	55	3	91
Current Cut (Average 1969-71)	25	19	2	46
Deciduous Volume, MM C.F.				
Net A.A.C.	15	40	3	58
Committed (FMA or QUOTA)	-	-	-	-
Current Cut (Average 1969-71)	-	-	-	-
All Spp. Volume, MM C.F.				
Net A.A.C.	99	95	12	206
Committed (FMA or QUOTA)	33	55	3	91
Current Cut (Average 1969-71)	25	19	2	46

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* Million Cubic Feet, Presently Merchantable

G1, outside the study area. Similarly the FMA timber of NCFI is currently drawn from the project area, but will later come from presently immature or undeveloped portions of the FMA outside the project area.

More recent and detailed allowable cut calculations accompanied the Forest Service inventory compilation prepared in May, 1973. These calculations are summarized, for conifers only, and by individual tenures, in Table 3.4 (1973 Estimates of Coniferous Allowable Cut by Forest and Tenure). These are virtually identical in summation to the totals shown in Table 3.3, and also conform closely to the official allowable cuts of NWPP and NCFI (excluding portions of this FMA outside the project area).

The net allowable annual cut established for the project area is 148 million cubic feet (MM C.F.). An additional potential for cutting of 58 MM C.F. of deciduous species exists, and would increase the allowable cut to 206 MM C.F.

Existing Crown commitments for long-term sale of timber (FMA or quota) amount to 91 MM C.F., just over 60 percent of capacity. That portion of the area in the Grande Prairie Forest is virtually fully committed to coniferous cutting by PG, NCFI and Imperial Lumber Company Limited. A substantial volume of deciduous cutting, 40 MM C.F. is still uncommitted, however. Only 39 percent of the Edson Forest portion of the project area is presently committed. Further commitments of Crown lands in Management Units E7, E8 and E10 are not unlikely. Current cut in Table 3.3 is expressed as a three year average extending into 1971. During this recent period the volume cut was 46 MM C.F., considerably short (50 percent of the conifer volume committed), and far short (31 percent) of the net allowable conifer cut. Post-1971 cutting has increased sharply. By 1974-75 Procter & Gamble will be in full production, and the annual cut for the entire area will approach the volume currently committed.

TABLE 3.4

ESTIMATES OF CONIFEROUS ALLOWABLE CUT BY FOREST AND TENURE

FOREST	TENURE					
	PG FMA	NCFI FMA	NWPP FMA	Crown	Total Project Area	Total 1972 Statement
	Net Allowable Annual Cut, MM C.F., Trees 4"+					
Grande Prairie	48.9	8.1	-	-	57.0	55
Edson	-	-	31.8	50.9	82.7	84
Whitecourt (W-1)	-	-	-	8.8	8.8	9
TOTAL	48.9	8.1	31.8	59.7	148.5	148

Source: AFS, May 1973. Volumes are million cubic feet, trees 4 inches and over, after projection of growing stock to 1973 and reductions for "green belts", cull, fire, industrial damage, and inoperability. Allowable cuts calculated by Von Mantel's formula, using appropriate rotation ages.

All allowable cut calculations of the Forest Service are applications of the Von Mantel Formula, accompanied by percentage reduction factors to account for predicted fire, cull and other losses. The formula is properly applicable only when a normal (equal) distribution of all age classes is present. This condition does not prevail on the area or its parts, but the lack of reliable acreages by age class has prevented the use of more sophisticated calculations. The Forest Service, quite properly in the absence of better data or of cutting levels at or near capacity, has relied upon conservative use of the Von Mantel Formula.

An opportunity to test the validity of the established allowable cut and its adequacy in supplying existing plants occurs in the case of the NWPP Lease area, for which comprehensive inventory data are available. The official allowable cut for the Lease is 380,000 cords (32,300 M C.F.). Existing plant capacity is for 200,000 tons of bleached kraft pulp and 50,000 M B.M. of lumber annually. Calculations to determine whether these values are realistic are shown in Appendix III-2. Wood requirements were first calculated using conservative conversion factors. With allowances for the use of purchased wood and sawmill residues, and for current losses to seismic operations, a cut of 35,400 M C.F. is required from the Lease. A composite yield curve was then prepared for growth projections of spruce and pine stands in the proportions present. Finally an area-volume check for the required 35,400 M C.F. cut was made. Company summaries of acreage by age-class were used, and allowances for fire, cull and avoidance of unmerchantable stands or protected areas were applied. These calculations indicate that the required conifer volume can be extracted each year, and that the rotation will be extended to 93 years rather than the proposed 80 years. This thirteen-year lag in commencement of the second rotation would be a welcome margin in the event that restocking delays cannot be prevented. Additional safety factors will exist if wood or chip purchases increase, if fire-killed stands can be salvaged more heavily, if deciduous species can be utilized, or if seismic exploration losses are curtailed.

In the case of NWPP at least, the official allowable cut does not overtax the capacity of the forest under safe management. The presence of safety factors like those above and of uncommitted cut volumes provide strong assurance that overcutting is unlikely in the project area.

3.1.9 Forest Service Administration on Project Area

Of some 1,386 temporary and permanent staff in the Department of Lands and Forests (Department of Lands and Forests Annual Report, 1971), 547 permanent members of the AFS (Personnel List, December 1972) have direct responsibility for management of provincial Crown forests. Table 3.5 indicates the distribution of AFS staff. Of these, 165 are based in Edmonton, and 382 stationed on the eleven Forest headquarters or the 58 ranger districts within the forests. No doubt staffing is a function of fire hazard, forest industry activity, and many other elements besides allowable cut, but in terms of allowable cut alone, the AFS distribution of staff is as follows:

TABLE 3.5

ALBERTA FOREST SERVICE STRUCTURE
(DECEMBER 1972)

1. Headquarters Staff, Edmonton

Branch	Permanent Staff
Administration	12
Depot	8
Training Branch	13
Timber Management Branch	42
Land-Use Branch	26
Forest Protection Branch	28
Construction and Maintenance Branch	36
TOTAL PERMANENT STAFF	165

2. Provincial Forest Staff

Forest	HQ Staff	No. Ranger Districts	Perm. Ranger Dist. Staff	Conif. A.A.C. (MM C.F.)
Crowsnest (Blairmore)	8	4	9	8
Bow River (Calgary)	17	5	19	20
Clearwater-Rocky (RMH)	18	9	17	46
Edson	22	4	22	100
Whitecourt	21	5	18	46
Lac la Biche	17	4	15	28
Athabasca (Ft. McMurray)	14	4	10	48
Slave Lake	22	7	29	65
Grande Prairie	21	5	17	61
Peace River	18	7	16	40
Footner L. (High Level)	17	4	15	55
	195	58	187	517

TOTAL FOREST STAFF	382
TOTAL FOREST SERVICE	547

SCHULCO

		Permanent AFS Employees per MM C.F. of A.A.C.		
Area	A.A.C. (MM C.F.)	Forest Headquarters	Ranger Districts	Total
Provincewide	517	0.38	0.36	0.74
Edson Forest	100	0.22	0.22	0.44
Grande Prairie Forest	61	0.34	0.28	0.62
Whitecourt Forest	46	0.46	0.39	0.85

These ratios suggest that the presence of FMA's administered by industry reduces the number of AFS staff necessary in a Forest. Whitecourt Forest, for example, requires more staffing per MM C.F. of allowable cut than do Edson or Grande Prairie Forests, perhaps because of the absence of forest management by industry in the Whitecourt Forest.

The interior Forest Districts in British Columbia can be considered as the equivalent of an Alberta Forest headquarters, with allowances for scale and for the extent of outside support. The parallel measures of staff per million cubic feet of allowable cut are respectively:

Forest District	Permanent Staff	A.A.C. (MM C.F.)	BCFS Staff per MM C.F.
Prince George	348	846	0.41
Kamloops	335	293	1.14
Nelson	239	286	0.84

SCHULCO

With proper allowances being made, the B.C. Forest Service permanent staff per MM C.F. of allowable cut appears somewhat higher than that of the Alberta Forest Service. A parallel comparison based on current cutting rather than allowable cut produces similar results. No fundamental differences in the training, experience, or ability of comparable staff can be noted. Compared with American National Forest staffing, both provinces appear to receive good management for their respective investments in personnel. In the case of the project area, future preoccupation with environmental protection and other problems probably will require staff reinforcement. The frequency of staff transfers has been noted as a possible problem leading to lack of continuity in management.

3.1.10 Forest Administration by Industries

In the Forest Management Agreement areas, company forestry and wood production staff fill roles otherwise taken by AFS personnel. Often logging and construction contractors also undertake a degree of responsibility under overall supervision of the company. The Woodlands Section of NWPP includes 68 salaried persons, with 18 in forestry (0.40 per MM C.F. of A. A.C.), 13 in operations, and 24 in scaling. The NCFI Woodlands Division is similarly staffed in relation to its production, and the Procter & Gamble Woodlands Division promises also to be similarly staffed. The training and ability of staff members are entirely suitable.

It is difficult for quota holders and licensees to provide supervision for forestry programs, most of which are not yet advanced to the stage of year round work loads. A combination of company effort, temporary use of consultants, and extra attention from the AFS probably will normally be necessary.

3.1.11 Administrative Controls

The Alberta forest administration philosophy is familiar in Canada. Lessees or licensees plan and execute forestry practices within guidelines provided. The Forest Service function is to inspect, guide, and approve or disapprove. Company self-interest and staff professionalism normally assure adequate management. Various penalties, including total shutdown in serious cases, can be invoked. AFS supervision depends upon the following controls:

a) Management Plans (FMA's Only)

Each FMA holder is required to prepare a management plan following commencement of the agreement, and to revise this periodically thereafter. These plans, prepared in accordance with an AFS "Outline of the Forest Management Plan of the Lease Area" (1963), describe the area and circumstances, present details of forest inventory, derive allowable cut figures, outline long-term development plans, and propose harvesting, silvicultural, and administrative methods which will lead to proper sustained yield management. Management plans for NWPP and NCFI are available; that of PG is not yet completed and presumably would still require early revision after necessary inventory surveys and development planning are completed.

b) Annual Operating Plans (Holders of FMA's and Quotas)

Road and cutting developments, reforestation or site preparation, and other forest management activities planned for each year are presented in an Annual Operating Plan (A.O.P.). Commencement of the new year's operations depends upon AFS approval of the A.O.P., which may be withheld until unsatisfactory past treatments are corrected.

c) Ground Rules (holders of FMA's and Quotas)

A recent development to reinforce local supervision has been the preparation of Ground Rules. The Alberta Department of Environment, in consultation with land and resource based Departments, drafted 'Land Conservation Guidelines" late in 1972. These were designed to provide environmental protection of forest and non-forest lands and waters, and to apply to all users or developers. These guidelines outline protective measures to:

- withhold steep or sensitive areas from farming or timber removal;
- require planting of grass or trees for erosion control where necessary;
- prevent disturbance of streamside, lakeside, or highway margin vegetation, according to a series of rules and distance limits;
- regulate the location, construction, and maintenance of roads, for the prevention of damage to lands and waters.

It has been agreed that individual Department regulations and rules, while perhaps more specialized and detailed, would conform with the general standards set out in the Guidelines. The Forest Service-Company ground rules described below confirm with the guidelines.

This is important, both to prevent the appearance of contradictory rules from the different Departments, and to ensure that safe practices of one industry are not nullified by unsafe practices of another. NWPP and PG have signed 1973 Consolidated Ground Rules governing operations on their respective FMA's. The other FMA holder, NCFI, is governed by "Guiding Principles and Ground Rules for Cutting Practices" set forth in the company's latest Management Plan, and will probably be required to sign new ground rules in due course. Quota holders have not been required to sign individual ground rules, but AFS correspondence regarding the current A.O.P.'s of quota holders would indicate that if applicable, the measures contained in FMA ground rules are required on quota operations.

Fairness requires that ground rules impose equal burdens on all operators, with proper regard for any special circumstances. Both the NWPP and the PG Ground Rules are subject to review in December 1973, and presumably further annual or periodic reviews. This is an important feature, to insure fairness and effectiveness and to enable the incorporation of new techniques which will be developed.

The PG Ground Rules are the most recently developed. Except for special provisions of local significance, they probably typify the degree of regulation which will soon be required of all permanent operators. The PG Ground Rules are summarized briefly in Appendix III-3.1. Appendices III-3.2 and III-3.3 contain the full texts of the PG and the NWPP Ground Rules in effect.

The NWPP Ground Rules (Appendix III-3.3) are similar or equivalent to those of PG in many respects, but differ notably as follows:

1. The different classes of stream requiring different measures are mapped over the entire NWPP Lease. Application of the rules is in accordance with this map unless conditions on the site require special modification. As yet there is no corresponding mapping for the PG Lease. It is felt by PG that individual decisions on streams cause delays and extra layout work.

2. NWPP cutting under former rules in the Athabasca and McLeod Working Circles is well advanced into the first 20-year cutting cycle. The 1973 Ground Rules are not retroactive here, and will not apply until commencement of the second cycle. The PG operations are of course new and are not subject to this form of transition.

3. Clearcut block size is limited by approximately equivalent rules, except that the NWPP rules restrict cutting in spruce types, regardless of terrain, to strips not exceeding 10 chains in width. The PG rules permit large (500 acre maximum) spruce clearcuts on gentle terrain provided special reforestation measures are taken.

One of the more rigorous new rules is the "6 to 8-foot, 20-year Rule", which could delay removal of residual blocks. This rule creates an important new onus on both companies to obtain prompt and effective restocking of first-cut blocks.

The Alberta forestry ground rules are as detailed and demanding as any written rules for Crown forest management of conifers in Canada. In

Ontario there are parallel but less demanding policies presumably with individual obligations detailed within each contract signed recently (personal communication from R.M. Dixon, Director, Forest Management Branch).

In B.C., generalized Planning Guidelines for Coast Logging Operations (See Appendix III-3.4) were published recently. These outline general policy and are backed up by clauses contained in the newer agreements, by undertakings made in management plans and operating plans, and by ground decisions. The effects generally are good, but the lack of consolidation of all written obligations leads to confusion.

The combination of all legislation, management plans, annual operating plans, ground rules, and other written material governing forest management practices in Alberta is impressive. So also is the essential clarity and congruity of detail, in comparison with parallel situations in other provinces.

Until provisions for the harvesting of deciduous crops become necessary, there appears to be no need for major additional regulation in written form, in order to provide proper management on the project area. However, the training and staffing within the AFS and the companies, may well require supplementation to meet new obligations.

3.1.12 Fire Protection

The successional role of past fires has already been outlined. Modern forest management requires that harvesting replace fire in this role, and that unrecoverable fire losses be restricted within tolerable limits.

Recent Fire History

The Alberta Forest Service maintains fire records for the project area. Fire incidence maps and copies of computerized summaries were studied for the decade 1961 - 1970 to evaluate current conditions. Table 3.6 is drawn from these sources.

Table 3.6 shows annual averages of 56 fires, costing $118,520 to suppress, and destroying 5,346 acres, chiefly productive forest. Over 100 large fires in the single year 1961 caused 92 percent of the acreage burned over the entire decade. Burned acreage for the years 1962 - 1970 averaged only 433 acres per year. Years like 1961 will recur, but it is felt that fire protection standards have improved sufficiently to prevent such extensive damage in future.

Lightning was the major cause of fires, in terms of numbers (54 percent of all fires) but more conspicuously in terms of acreage (94 percent). Man-caused fires tend to be controlled more rapidly.

The 5,346-acre average acreage for the decade represents an estimated annual acreage loss of 0.07 percent, within the target of 0.10 percent set for managed lands, and well within this limit if the 1961 "bad" year is excluded. Considering the lightning hazard, further reduction of the target percentage is unlikely.

An estimated $125,000 per year would now be generated by fire protection charges at the current rate of $12.80 per square mile under disposition. This corresponds roughly with historic direct suppression costs, exclusive of overhead costs which are substantial. Elsewhere in Alberta the forest industry contribution to AFS fire protection is seldom so significant.

TABLE 3.6

HISTORY OF THE NUMBER, SUPPRESSION COST, AND ACRES BURNED FOR ACCIDENTAL FIRES 1961-70 WITHIN THE PROJECT AREA FROM ALBERTA FOREST SERVICE PRINTED RECORDS

FOREST DISTRICT		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	TOTAL
MAN-CAUSED FIRES												
WHITECOURT	NUMBER	2	1					2	3	1		9
	DOLLARS	941	99					222	333	12		1,607
	ACRES	12						10				22
GRAND PRAIRIE	NUMBER	9	2	1	1	1	4	10	1	4	23	56
	DOLLARS	14,413	922		30	123	241	588		5,165	74,187	95,669
	ACRES	1,162		3	2		129	461		5	181	1,943
EDSON	NUMBER	18	8	10	15	10	6	31	28	18	45	189
	DOLLARS	625	769	20,299	4,685	53	556	31,199	3,712	3,759	69,978	135,635
	ACRES	124	2	117	118	3	10	148	22	3	645	1,192
TOTAL	NUMBER	29	11	11	16	11	10	43	32	23	68	254
	DOLLARS	15,979	1,790	20,299	4,715	176	797	32,009	4,045	8,936	144,165	232,911
	ACRES	1,298	2	120	120	3	139	619	22	8	826	3,157
LIGHTNING FIRES												
WHITECOURT	NUMBER	5	3	22		1		2	1	1	1	36
	DOLLARS	54,886	1,006	40,843				6,492	784	5,327		109,338
	ACRES	898		7						2		907
GRAND PRAIRIE	NUMBER	30	9	22			3	16	9	1	17	107
	DOLLARS	243,323	10,968	9,038			437	11,935	2,155	25	19,907	297,788
	ACRES	17,012	40	4				2	2		39	17,099
EDSON	NUMBER	40	13	34	5	8	4	18	15	5	20	162
	DOLLARS	342,319	5,132	7,708	136	3,709	1,532	144,233	9,903	10,346	19,077	544,095
	ACRES	29,930	2	8				2,323	10	3	2	32,278
TOTAL	NUMBER	75	25	78	5	9	7	36	25	7	38	305
	DOLLARS	640,528	17,106	57,589	136	3,709	1,969	162,660	12,842	15,698	38,984	951,221
	ACRES	47,840	42	19				2,325	12	5	41	50,284
GRAND TOTAL MAN-CAUSED AND LIGHTNING FIRES												
NUMBER OF FIRES		104	36	89	21	20	17	79	57	30	106	559
COST - DOLLARS		656,507	18,896	77,888	4,851	3,885	2,766	194,669	16,887	24,634	183,149	1,184,132
BURNED AREA -	ACRES	49,138	44	139	120	3	139	2,944	34	13	867	53,441

FIRES - CAUSE UNKNOWN

DATE	8/69	6/63	5/67	5/69	5/69	5/70	TOTAL
COST DOLLARS	99	9	162	4	765	37	1,076
ACRES BURNED	-	-	1	1	8	19	29
FOREST	GRAND PRAIRIE	EDSON	EDSON	EDSON	EDSON	EDSON	6 Fires

Fire Risk

The risk of a fire starting will diminish as fireproofing by scarification extends, but will increase due to use of expanding road networks. Probably an overall increase in man-caused fire risk will occur, along with continuation of lightning fire risk at a constant level.

Fire Detection

A combination of manned lookouts and air patrols has assured prompt detection, and will continue to do so.

Fire Control

Extending roads, man-made fire-breaks, and augmented capacity for suppression from the air will continue to reduce the incidence of large fires, which are already infrequent. Improvements in meteorology and hazard rating will lead to better preparedness during critical periods.

The AFS maintains a superior fire protection service and assumes major responsibility for suppression of occupied and unoccupied Crown forests. Fire acreage losses have been well within tolerable limits on the project area since 1961 and statistically are unlikely to rise in future.

3.2 Road Systems

In any planned harvesting, a sequence is followed. The boundaries of logical cutting area are first fixed. The operator must then locate and build roads from which all cutting areas can be reached effectively, then complete the cutting, skidding, loading, and hauling phases of harvesting, and finally take the steps necessary for adequate restocking. The three main phases following initial planning are thus:

- Roads
- Harvesting
- Regeneration

Although these are obviously connected, they will be discussed separately in order that the problems peculiar to each can be examined.

3.2.1 Transportation in the Project Area

Roads

Within the project area there are three governmental agencies which administer roads: the Alberta Department of Highways, individual municipalities and the Alberta Forest Service. In addition there are roads built and maintained by industries: the forest industry, the mining industry, and the petroleum industry (see Table 3.7). Little or no coordination of planning of utilization occurs between these road owners or administrators.

i) The Alberta Department of Highways administers 163 miles of provincial highways which traverse the project area. The only completely paved

TABLE 3.7

TRANSPORT FACILITIES WITHIN PROJECT AREA

Owner	Amount in Miles	Right-of-Way Clearing in Acres[*]
Dept. of Highways	163	5,200
Municipal Roads	Not available but few	-
Forest Service Roads	704	11,300
Mining and Petroleum Industry Roads	634	10,200
Seismic Lines	14,500+	58,000+
Forest Industry Roads		
Main & Summer	453	9,060
Winter	299	4,700
Temporary	339	4,000
Total Forest Industry Roads	1,091	17,760
Railroads	356	7,100
Powerlines	224+	5,300+
Pipelines	325+	2,600+
Airfields (number)	15	275

Source: Schulco measurements

[*] Based on average right-of-way widths plus borrow pit areas.

highway is the Yellowhead Highway. Other all-weather highways are Number 47 in the Robb area and the highway to Grande Cache. It has been the practice of the Department of Highways to take over roads constructed by other agencies or by industry when public usage justifies take-over. Subsequently the Department of Highways will improve (or in most cases reconstruct) the road taken over. As a result there is a continuing abandonment of old roads or portions of roads. Roads abandoned for this or other reasons tend to mar aesthetic and other environmental values.

ii) Municipal Roads

Roads built and administered by municipalities occur within the project area, but these roads are not numerous enough to affect significantly the environment of the project area.

iii) Forest Service Roads

Forestry roads are built (or taken over) and maintained by the Alberta Forest Service. The principal functions of these roads are to provide access for forest management (mostly protection) purposes and for recreational purposes.

Many recreationists, local residents and industrial users commonly make extensive use of forestry roads. Industrial users are required to obtain a Road Use Permit and are consequently subjected to specified road use restrictions.

iv) Mining and Petroleum Industry Roads

Roads built and sporadically maintained by the mining and petroleum industries occur extensively throughout the project area. Some of these roads are of low standard; in some cases roads have been abandoned with little or no concern for erosion prevention.

v) Forest Industry Roads

Each major forestry company operating in the project area has its own road system, except for some shared road use. The two pulp companies have built all-weather main haul roads, but the non-pulp companies have only winter main roads. Recently, these latter companies have begun to upgrade some roads so as to initiate summer hauling.

Subsequent sections of this report will discuss these industry roads in detail.

vi) Railroads

Both Canadian National Railways and the Alberta Resources Railway have lines within the project area. These railways have a history of washouts and resulting adverse environmental impact. The Alberta Resources Railway which is in close proximity to the Smoky River between Grande Cache and Grande Prairie suffered major damage during the June 1972 flood and is presently inoperable.

vii) Other Transportation and Exploration Facilities

The project area is transected by powerlines and by several petroleum pipelines and is very extensively covered with seismic exploration lines. Many of these facilities have been constructed perpendicular to contour lines with little regard for erosion control measures, except in recent years when new Provincial regulations have been implemented.

Trenching for coal exploration purposes has been extensive in the Foothills areas. The environmental impact of these activities has been severe in localized and sensitive areas.

Finally, there are 15 airfields in the project area. Except for those at Hinton and Grande Cache, these airfields are small and many are serviceable only in the dry or frozen season.

3.2.2 Relevant Road Legislation and Regulations

Road tenure and usage in the project area are administered through the Public Lands Act, the Forests Act, the Public Highway Development Act, and the respective regulations and guidelines pertaining to these Acts. This report will only address matters relating to roads used by the forest industry.

Since private forestry companies are subject to load restrictions, truck licensing, and fuel taxes on public roads, these companies usually use only roads on which they have special occupation rights. Through a mechanism in the Public Lands Act, a private company is issued a License of Occupation (LO) by the Director of Lands. The term of an LO is stated, but occupation rights are not revoked until the industrial user no longer has need for the road.

Although occupation rights granted by the LO do not officially waive laws pertaining to load restrictions, fuel taxes and truck licensing, the Government of Alberta does not enforce any laws or regulations relating to these items. Posting of road regulations and enforcement are done by cooperation between industry and Government agents.

Free public access for people and private non-commercial vehicles on all roads in Alberta is assured except in special cases where temporary road closures are made by the appropriate Minister in severe fire weather or when necessary to protect road surfaces.

When more than one industrial user requires the use of a particular road, costs of road operation are shared. If agreement cannot be reached, the Director of Lands has arbitration powers.

Conflicts between industrial and public users of forest roads have been very few in Alberta. Nevertheless, several problems arise from the present procedures.

Road closures effected by the Minister of Lands and Forests (on behalf of LO holders) are resisted by fishermen and hunters since the closures generally occur during open seasons for fish and game.

The industrial users who have LO tenure are liable for accidents involving the public if it can be proved the industrial user was negligent in maintenance of the road or operation of equipment.

3.2.3 Alberta Forest Service Roads

(See Road System Overlay in Volume 2, showing all main roads in the project area.)

In keeping with the original needs of fire protection, many of the forestry roads are of low standard, usable only during dry or frozen seasons. The Forestry Trunk Road, the Grave Flats Road, the Two Lakes Road, and the Kakwa Road are the higher standard roads, but even these are the subject of public complaints concerning their safety and usability during rainy seasons.

The Alberta Forest Service does not have plans for local construction of new roads, except under special circumstances such as when Agricultural and Rural Development Act (ARDA) funds are made available. Recent construction (e.g., the Grave Flats Road) has been done with ARDA funds.

There is no indication on the part of the Forest Service that forestry roads have been integrated into any long-range road system plan for the project area.

Standards

Appendix III-4 states the standards of Alberta Forest Service roads. Analysis of this table will show no specifications relating to the load carrying capability of these roads. In fact most of the roads are usable only by light vehicles in dry seasons. When industrial users are required to use a forestry road for log hauling, they are usually required to strengthen the road structure or to haul only in frozen seasons. Maximum bridge loadings are 20 tons in many cases and 5 tons on one important crossing.

Field observations disclosed that the road standards stated in Appendix III-4 are not always followed. Cut and fill slopes and maximum grades are commonly steeper than indicated.

Construction Methods and Costs

Forestry road grading is done conventionally with dozers and trucks or with scrapers on larger projects. In general, the procedure is to lay a base of compacted clay. Turnpike ditches are commonly used as sources of base material. If the road is gravelled, only a very sparse 300-400 yards per mile are used.

The estimated cost of new construction on Class I roads in recent years is as indicated in Table 3.8.

TABLE 3.8

RECENT FORESTRY ROAD CONSTRUCTION COSTS

Item	Unit Cost	Cost per Mile $
Clearing	$250-$300/acre	$3,300
Grading and Ballasting	-	6,000
Gravelling - pit run (i.e., Surfacing)	$1.20/yard for 6-mile haul	500
TOTAL		$9,800

Forestry road maintenance is the responsibility of each Forest Superintendent. In the 1971-72 fiscal year road maintenance costs varied from $190-$500 per mile, with the Edson District being about average at an overall maintenance cost of $ 385 per mile. However, it should be noted again that these roads do not normally carry heavy traffic.

Measures and/or guidelines for reducing the environmental impact of forestry roads are not well developed. There has been limited environmental awareness indicated by the individuals involved in planning, construction and maintenance. The principal problem areas are:

- inadequate (or non-integrated) road system planning;
- limited evidence of aesthetic considerations in original design (some roads are now of high recreational value);
- lack of adequate erosion prevention measures;
- blockages of fish passage through culverts.

Generally, maintenance of drainage structures has been good on AFS roads. Slash disposal and revegetation of bared areas has been to a higher standard than that followed by industrial road builders.

3.2.4 Forest Industry Roads

The forest industry is by far the most extensive and intensive user of roads in the project area. Approximately 48,200 truckloads of logs are transported annually and this figure is likely to increase to 58,500 truckloads by 1985.

The average haul distance at present is approximately 50 miles and this figure can be expected to increase slightly.

Logging trucks are large in comparison to regular highway trucks. Load lengths are up to 130 feet; gross truck weights are up to 200,000 pounds; bunk widths are up to 14 feet. Furthermore, the economics of log transportation favor still larger loads, so that in future it is reasonable to expect loads up to 300,000 pounds and 16 feet in width, as well as tractor trains with up to 500,000 pounds gross weight. For reasons of safety and hauling efficiency the forest industry understandably needs to retain a private road system whose principal function is log hauling.

Standards

The two major pulp companies, as noted earlier, have all-weather main hauling roads. Their hauling road standards are specified in Appendices III-5 (Procter & Gamble) and III-6 (North Western Pulp and Power). Both Appendices include sections of the Ground Rules of the Alberta Forest Service relating to the respective companies.

Reference to these tables indicates a lack of uniformity in road standards. It appears that each company has been left to decide its own economic justification of road standards and its own interpretation of the meaning of multiple use.

One feature similar in both, however, is the limitation in bared width along rights-of-way. Since much of the ballast comes from turnpike ditches, industry and government engineers have developed a "bared area" formula so as to control the area within a road right-of-way that is stripped and exposed to erosion.

Lumber companies operating in the project area have not built all-weather roads. Appendix III-7 is the reported road standard system used by North Canadian Forest Industries (NCFI).

According to NCFI management, however, these reported standards are loosely interpreted, and often are overridden by ad hoc decisions made by construction personnel.

Appendix III-8 lists and summarizes forest road standards from selected companies in Alberta, British Columbia, Ontario, Quebec, and the United States.

Analysis of these standards and guidelines (see Table 3.9) indicates that Alberta has less stringent environmental guidelines relating to forest roads than the U.S. Forest Service but more stringent environmental guidelines than other provinces of Canada. The area in which Alberta appears to lag behind other areas is in long-range forest transportation planning for multiple use.

Road Construction Methods and Costs

The method of location and design of forest industry roads varies widely between individual companies. The two large pulp companies tend to do much more engineering than the smaller lumber companies. This is logical and justifiable since the pulp companies will have a much greater volume of traffic. Construction is generally undertaken in the summer and fall period (May through October). Occasionally winter construction is undertaken.

Highly competent construction materials are scarce throughout the project area except for occasional alluvial and till deposits as indicated in the Surficial Geology Overlay (Volume 2). Generally, surficial materials become finer-grained as one proceeds toward the northeast of the project area. In North Western Pulp and Power's area the average gravel haul is 5 miles. In Procter & Gamble's area the average gravel haul is now about 15 miles. Bedrock outcrops are also scarce along main road routes.

TABLE 3.9

COMPARISON OF ROAD STANDARDS AND GUIDELINES

Item	Alberta	B.C.	Ontario	N.W.T.	US-SW	US-NW
Uniformity of road standards	Poor	Some	Poor	N/A	Good	Good
Multiple-use standards	Poor	Some	Some	Good	Excellent	Excellent
Long-range system planning	Some	Good	Some	Good	Good	Good
Free access by public	Excellent	Mixed	Poor	Good	Good	Good
Erosion prevention measures	Good	Poor	Poor	Good	Excellent	Good
Streamside protection	Good	Poor	Some	Excellent	Excellent	Some
Preventing fish barriers	Poor	Some	Some	Good	Good	Good
Aesthetic considerations	Some	Some	Some	Good	Excellent	Good
Environmental education	Poor	Some	Some	Good	Good	Good

N.W.T.	Northwest Territories
US-SW	United States - Southwest
US-NW	United States - Northwest

Gravel is available from within the highwater wetted perimeters of some major streams (e.g., the Smoky River), but these areas are sensitive to environmental damage.

Road construction equipment utilized by the forest industry on main roads is usually scrapers and dozers; on branch roads, ordinary dozers.

The present general practice of the forest industry in regard to individual road items is as follows:

i) Bridges

Main road bridges are normally permanent steel and concrete structures. Bridges on winter roads and other roads are log stringer and sill structures. In some cases, temporary log or timber bridges are used during the winter and removed each spring.

ii) Culverts

Culverts are preferred to bridges because of reduced cost and maintenance. Culvert design is based on hydrological principles, with little or no regard given to fish passage. Of 105 known and potential fish-stream crossings inspected during the course of field studies, 40 were found to be impassable to fish moving upstream. Field studies indicated low standards in regard to installation of rip-rap, downspouts and other erosion-prevention measures. As a consequence, numerous culvert washouts have occurred in past years.

iii) Right-of-way Clearing

Timber on rights-of-way is felled and machine-cleared. All merchantable timber is prelogged to landing areas. Slash formerly was buried, but recent requirements are for burning and burying within one year after construction. Burying of slash under road embankments is common practice (refer to Road Standard Guidelines of individual companies).

iv) Borrow Pits

Borrow pits are generally small, and located at frequent intervals for the use of scrapers. Pits generally are not used repeatedly, and some attempts have been made to make them aesthetically acceptable. For example, recent practice has involved the leaving of a roadside screen of standing trees.

v) Ditches

The prevalence of violent rainfalls places importance on ditching. Most roads are well ditched, but often ditch blocks are made of incompetent material resulting in unnecessary erosion and stream sedimentation. Generally, the main concern is that ditches on stream approaches tend to run directly into the stream.

vi) Revegetation

Areas where soil is exposed on cuts, fills, ditches or natural slopes now require revegetation. The Alberta Forest Service provides specific recommendations, and the companies have experimented with different techniques. Since this practice is new to the forest industry, failures might be expected and were observed in some cases.

vii) Special Erosion Prevention Measures

The present ground rules provide for utilization of off-take ditches, terracing, rip-rapping, and leaving vegetation filters, but field observations disclosed only very infrequent cases where any of these techniques were employed. The only exceptions on operations of the forest companies were recent installations of ditch blocks and off-take ditches.

viii) Aesthetic Considerations

Other than cleaning rights-of-way of slash and debris, no consideration has been given to aesthetics. It is last on a long list of priorities.

Industry officials feel that the public should be educated to accept the conventional industrial road appearance.

ix) Industry Road Costs

The cost of forest road construction in the project area varies from $500 to $35,000 per mile depending principally on road standard, type of terrain, and distance of ballast haul. However, $15,000 to $20,000 per mile is the average cost of main road suitable for heavy winter hauling (see Table 3.10). Main all-weather roads require considerably more surfacing

TABLE 3.10

COST OF INDUSTRY MAIN HAUL ROADS

Item	Unit Cost	Cost Per Mile
Clearing	$250/acre	$4,000
Grading	45-50¢/yard	$10,000
Crushing	$1.50/yard	$1,500
Gravelling	$1.95/yard at 15 miles	$1,950
Drainage Structures	Average	$2,000
		$19,450

than the 1,000 yards per mile indicated in Table 3.10, and thus may approach the $35,000 extreme whenever conditions are adverse.

Poorly timed construction may add substantially to both cost and environmental damage. One example of May construction on poorly drained terrain illustrated the importance of this factor. With fall or winter construction, the same road undoubtedly would have been cheaper, less subject to future erosion, and free of most of the downstream sedimentation which occurred.

Planned Road System

Except for Procter & Gamble and central uncommitted Crown forest, most of the main and trunk road system in the project area is completed. Regular annual extensions and occasional major link-ups can be expected over the next 25 years, but some deceleration in road construction programs can be anticipated. Table 3.11 indicates the approximate situation arising from forest industry activities up to 1985 and to 2000 A.D.

In the case of Procter & Gamble, about one-half of the main and trunk road system is yet to be built. This remaining road system will be mostly in the western areas of their FMA area.

Apart from these industry programs, it is understood that the Alberta Department of Highways will build a new highway between Grande Prairie and Grande Cache. This highway will parallel the Forestry Trunk Road and many miles of forest industry roads. Therefore the amount of duplication of roads south of Grande Prairie will increase. Three forest product companies, the Department of Highways, and the Forest Service will be maintaining parallel main roads spreading from Grande Prairie like asymmetrical spokes on a wheel.

TABLE 3.11

AREA CONSIDERED NON-PRODUCTIVE DUE TO ROAD COMPACTION AND BARING OF R/W

Year		1985			2000		
	Road Class	I + II	III	Skid	I + II	III	Skid
Industry & AFS Roads	(1) - mi.	2,421	1,101	1,236	3,426	1,037	1,183
Cleared R/W existing	(2) - ac.	19,400	4,000	Nil	27,400	4,300	Nil
Area Bared (incl. road-beds)	(3) - ac.	23,400	10,000	3,200	33,200	9,400	3,070

TOTAL area not productive due to roads in 1985 = 36,600 ac. (.42% of total P.A.)

in 2000 = 45,700ac. (.52% of total P.A.)

Source: Schulco estimates derived from forest company estimates of road construction.

Notes:

(1) Roads existing in 1985 & 2000 assuming I & II are permanent, III have 4 years life, and Skid have 1 year life

(2) Assumes 50% of I & II not in settings; 30% of II not in settings. R/W width, I & II - 132', III - 100', incl. pits and widenings.

(3) Assumes 80' for I & II, 75' for III, 16' for skid & only 65% results in baring so as to allow for winter logging. Skid roads are assumed to be restored after 2 years.

(4) Not including future operations in E10, E8, E7, E6, E5 and W1

Total Average Surface Disturbance Attributable to Forest Roads

At the present time, there are approximately 1,800 miles of forest road in the project area including AFS and forest company roads, but excluding highways and skid roads. By 1985, the amount of road can be expected to increase to 3,500 miles; by 2000 it will be 4,600 miles. (These calculations exclude all temporary roads older than four years. Further, the AFS is not assumed to build any new roads.)

Table 3.11 summarized the extent of disturbance and compaction arising from these anticipated roads. By 2000 A.D., about 46,000 acres, or 0.5 percent of the project area, will be withdrawn for road use. This is excessive only if roadside erosion is not controlled.

Use of Roads by Non-Industrial Parties

All roads in the project area are used by local residents, campers, sport fishermen, and hunters. Two major items warrant attention from an environmental point of view.

Firstly, in coming years, camping may become uncontrolled despite the fact that many more campsites have been built. The problem is that uncontrolled camping along many available roads would result in widespread fire risk, accumulations of garbage, and other pollution.

Secondly, a vast and dense road system will inevitably cause localized over-harvesting of game. For this reason, the deliberate destruction or "putting-to-bed" of roads no longer used may be desirable as a fish and game management tool. The companies indicate a willingness to apply this practice wherever future access for harvesting, protection, or reforestation is not needed.

3.3 Harvesting

3.3.1 Cutting Practices and Patterns

Cutting practices in the project area as elsewhere are at some level of compromise between ideal silviculture and ideal harvesting efficiency. To date this has almost invariably involved a pairing of equal "first-cut" and "second-cut" areas of merchantable timber within an operating or drainage area. All first-cut blocks are then clearcut over a ten-year period. When these are adequately stocked all second-cut blocks are harvested and left for restocking. The cutover area is then left for a full rotation less 20 years. This system is referred to as the 50 percent cut-leave system. Fundamental questions concerning the state of first-cut blocks, when adjacent second-cut timber is removed, have been raised. These questions, and measures to settle them, are discussed in this section and elsewhere.

Windfall damage in "leave" blocks occurs sporadically and necessitates salvage in advance of the second-cut at times. This is more common in spruce than in pine but seldom alters the cutting pattern fundamentally even in spruce types.

Two cut patterns will henceforth be used within this system as follows:

1. Block or patch cutting (pine types on gentle terrain or spruce types (PG only)). Block size limits are generally 80 acres for sawlog harvesting and up to 500 acres (averaging 350 acres) for pulpwood operations. The scattering and opening of the serotinous pine cones (usually aided by scarification), assures restocking in most pine types.

2. Strip cutting (all spruce types except those under stated circumstances for PG, and pine types on all steep terrain). This pattern consists of parallel strips from 10 to 20 chains wide but of no specified maximum length. These must parallel the contours on steep ground, but strips should also be approximately perpendicular to prevailing winds where effective spruce seed dissemination is needed.

The planning of effective harvesting patterns and accompanying road systems requires experience and skill. The forester must insure that the Ground Rules are observed, and yet create a plan which minimizes harvesting and road cost. Time for planning is often limited. Maps and photographs are not always available or suitable.

Size of Clearcuts

On a purely cost basis, operators logically would harvest all merchantable timber stands tributary to each road developed, commencing with areas closest to the plant. The unanimous objections of foresters to this approach brought about the 50 percent cut-leave system and clearcut size limitations specified in ground rules. Block and strip sizes will normally be close to the upper limits set, examples of which are shown in Table 3.12.

Conifer Utilization Standards

Coniferous trees over 5 inches in stump diameter are cut and utilized to a 4-inch top inside bark in pulpwood harvesting. Standards for sawlog and peeler harvesting are for trees over 8 inches in stump diameter, to be utilized to a 4-inch top diameter. From observations of cutovers and truck loads, utilization more than satisfies these requirements on the NCFI operations, at least during current market conditions. This is true to almost the same extent for other sawlog operations observed.

TABLE 3.12

RULES GOVERNING MAXIMUM BLOCK ACREAGE OR STRIP WIDTH OF CLEARCUTS

ZONE AND SPECIES	PG RULES	NWPP RULES	NCFI RULES
Gentle or Lowlands:			
Pine	500 acres[1]	500 acres[1]	100 acres
Spruce	250 acres[2]	660 feet	40 acres
Steep or Foothills:			
Pine	990 feet	1320 feet	100 acres
Spruce	990 feet[3]	660 feet	40 acres

[1] Maximum acreage for an individual clearcut A series of clear-cuts must average not more than 350 acres.

[2] Probably PG will fulfil the Special Reforestation Provisions for spruce upon which this limit is conditional. If not, a 660-foot strip width will apply in this case.

[3] Strip width limits will be relaxed where the presence of residual deciduous trees affords significant erosion protection.

Since there is no longer a great difference between pulpwood and sawlog utilization practices, or in the respective harvesting methods, it would be desirable to apply pulpwood size standards on all operations. Sawmill operators would then supply unused wood to the pulp mills in round or chip form, and receive payment or sawlogs in exchange. Incentive formulas to encourage this new practice are urgently required in the Grande Prairie area. It is difficult to visualize all of the combinations under which such exchanges would be made, but suggested principles upon which pricing formulas could rest are:

1. Logs sold or exchanged should be suitable for the stated purpose.

2. The price of sawlogs sold from a pulp operation (for example, PG) should not be less than the seller's audited delivery cost, plus stumpage paid, plus a reasonable profit margin. Neither should this sawlog price be more than the average delivery cost, plus stumpage, plus the same reasonable profit margin, as experienced on regional sawlog operations.

3. The price of pulpwood sold from sawlog operations should not be less than the realistically appraised delivery cost to the seller for the pulpwood component extracted, plus any stumpage paid, plus a nominal profit margin. Neither should this byproduct pulpwood price be more than current pulpwood production costs plus stumpage of the pulp mill buyer on its own operations.

4. Wood chip prices delivered to a pulpmill should not be less than realistic production cost for the seller's individual circumstances. Neither should they be more than the buyer's current chip production cost.

It is envisaged that the Forest Service, perhaps with the assistance of acceptable and disinterested consulting firms, would play a vital role in setting upper and lower price limits. The buyer and seller would then establish contract prices somewhere between these limits by negotiations. Since such transactions are to the advantage of the Crown, stumpage concessions should be used to increase the probability that the seller's total costs are less than the buyer's parallel costs. Even so, situations involving extreme hauling distances may not conform with the above principles.

Utilization of Poplar

The considerable inventory of deciduous species (poplars) on the project area is unutilized at present, and will not be fully used except by the pulp companies. An incentive for poplar use in pulping exists in the form of reduced stumpage rates. Pulping or other use of poplar would develop if plant expansion beyond the coniferous capacity of surrounding forest lands were desired. For these reasons it is likely that poplar use will materialize eventually, and will intensify the environmental effects of clearcutting in some localities. This eventuality, however, is outside the scope of the project.

3.3.2 Harvesting Methods

The two pulp operations proceed throughout most of the year. Sawlog operations are normally in the winter months only. For example, NCFI aims at delivery of the annual log supply during only 80 days in December, January, February, and March. A brief description of the harvesting phases is as follows.

Felling and Skidding

Power-saw operators are employed by NWPP for most felling and delimbing, and various forms of rubber-tired skidders are used for moving tree lengths to the roadside. The feasibility of mechanized felling with a tracked feller-buncher is being assessed. Also the use of forwarders is under consideration, as a means of reducing spur road density, which is now based on rubber-tired skidder distances not exceeding about 1,000 feet.

Similar techniques are used by NCFI, except for the recent operational introduction of a tracked Drott feller-buncher which competes successfully with saw-felling on gentle terrain and timber up to approximately 16 inches in stump diameter. The combination of grapple-skidders with the feller-buncher appears effective, but delimbing must be completed at the landing except in extremely cold weather.

Procter & Gamble made a bold departure from conventional equipment and methods. Although saws are used on large trees or steep terrain, the basic felling equipment is the Caterpillar Harvester. This machine, believed capable of handling 14,000 cords per operating year, is mounted on rubber tires, fells the trees with hydraulic shears, feeds tree lengths through a delimbing device, and bunches them for skidding by grapple-skidders. The harvester-skidder teams appear reasonably effective on slopes currently being logged, and would ordinarily improve as the new personnel gain experience. On all operations seen, bulldozers are used for road and landing work, skid road improvement, and occasional yarding. Both contractors and company pulpwood crews are involved in these woods phases. The level of supervision appears adequate, and utilization with only a few exceptions was complete.

Loading

Average tree size is small (e.g., 9 cubic feet per tree on pulp operations). Handling of single pieces is therefore rare. NWPP and PG load largely with rubber-tired, grapple-equipped overhead cranes. NCFI and other sawlog operators generally use track-mounted or rubber-tired front end loaders. This equipment is versatile and mobile, but requires use of prepared landings and therefore would lose effectiveness on steep slopes.

Hauling

Almost all hauling is in tree lengths, on trailer trucks. Hauling contractors occupy a prominent place in this phase. Hauling distances are relatively long, and main road speeds must therefore be relatively high. Only the main roads of the pulp companies permit serious summer hauling. Most operators or their contractors haul on private roads which permit the use of wide off-highway bunks. Depending on truck size and timber, loads vary from 75,000 to 120,000 pounds (20 to 25 cunits).

Weighing, Unloading and Scaling

The mills seen were invariably equipped with scales for the weighing of truck loads, coupled with some system of bucking and sample-scaling in the mill yard. Sample-scaling is done by licensed private scalers under Forest Service supervision, and appears accurate and based on sound statistical principles.

3.3.3 Problem Areas

Potential problem areas observed in the field of harvesting are:

1. Woods Manpower

   Until year-round operations can be expanded, approximately half of all woods jobs in the project area will be seasonal. Isolated camps are still in use for the same reason. Particularly under these circumstances, skilled personnel are difficult to attract away from steadier or more lucrative alternatives in the construction or mining industries. Generous welfare policies also are considered an attractive alternative by some potential woods workers. With expanding labor needs, the quality and quantity of labor will be critical factors in the woods. Several training schemes sponsored by companies and/or government are in operation, but the numbers trained are not yet adequate. There is undoubtedly a direct relationship between the quality of woods personnel and the environmental effects of woods operations.

2. Mechanization

   The manpower shortage is accompanied by the need to mechanize woods operations. Procter & Gamble is an excellent example. Many (but not all) effects of mechanized harvesting are good. Expensive machines like the Caterpillar Harvester, loaders, and large logging trucks require fewer men but must be well maintained and operated by skilled people. A tendency toward increased destruction of understory trees and compaction of the soil is also a possibility.

3. Future Harvesting on Upper Slopes

Most harvesting to date has occurred on relatively level areas. The near future will bring a higher proportion of extraction on steep slopes. Stand volume per acre and piece size have so far discouraged application of cable systems, but erosion control considerations may impose these systems on such areas. Light, inexpensive cable yarding systems adaptable to conditions on the area have not yet successfully been explored. Perhaps balloon harvesting will provide the needed combination of speed, mobility, light rigging, and protection of soils.

One recent application of crawler tractor skidding down steep slopes (the Terris operation) exhibits signs of erosion. Other, older examples seen from the air appear relatively free of serious erosion, but timbered areas on still steeper slopes await future harvesting.

3.3.4 Harvesting Economics

Crown Stumpage - In addition to Crown charges for ground occupation and fire protection described above, operators pay stumpage charges regularly on the volume of timber cut. These charges are fixed by negotiation for lengthy periods in the case of all pulpwood cut by the pulp companies (currently $1.00 per cord for NWPP and $1.15 per cord for PG). Stumpage on all sawlogs cut by these or others (including veneer logs) is set by the appraisal system of the AFS. Under this system Regulation Rates of Crown Dues are set as a graduated percentage of average market value (AMV). The AMV is a three-month moving average mill net price, for finished dimension lumber of the grades and species sold. This average is objective, in that it is derived from monthly indices published by the U.S. Department of Labor. The Timber Management Regulations contain a schedule of regulation rates of Crown Dues, establishing the stumpage rate payable for a given AMV, under average Alberta logging conditions. Appendix III-9 is a copy of the regulation rates currently in effect. Dues rise from 5 percent of AMV at $65.00 per M F.M. to 15 percent of AMV over $105.00 per M F.M. The percentages appear to be arbitrary, but reasonable under average conditions. Regulation rates for various minor products are also published.

An individual appraisal is periodically performed by the Timber Management Branch to determine the extent to which a particular sawlog operation departs from average values for the following factors:

- road and hauling costs (average 61 miles);
- gross volume per acre (average 13 M B.M.);
- tree size (average 161 F.B.M.);
- defect percentage (average 10 percent).

Formulas are used for derivation of a "dollar factor" by which local stumpage charges are raised or lowered from the regulation rate.

In a few cases of extremely poor logging chance a minimum charge of 50 percent of regulation rates is charged, regardless of the dollar factor derived. This is said to apply to the operation at Sherman Meadows, largely because of its remoteness.

Operators have the right to appeal their appraisals, but cases of this are not numerous, and the issue of sawtimber stumpage appears slightly less contentious in Alberta than elsewhere.

Current sawtimber stumpage is in the neighbourhood of $18.00 per M B.M., or $9.50 per cunit. Current pulpwood stumpage is in the order of $1.30 per cunit. In terms purely of government stumpage revenues, it would be most desirable that all timber surplus to the needs of the two pulp mills be utilized as sawtimber. A significant proportion of most mature stands being cut is suitable for sawtimber, and could generate several times the stumpage revenue by being so used. It appears that some wood of sawlog quality will inevitably be pulped, with some sacrifice in stumpage and company revenues. The choice was formerly between pulp utilization or no utilization. However, the future addition of sawmills producing pulp chips would partially correct this imbalance. Eventually revenues from pulp operations may be fully as high as those from sawlog operations.

Stumpage for all timber cut is related ultimately to selling prices of forest products, so that Alberta can share in the prosperity of an industry which in turn can be assured that the stumpage burden does not unduly hinder future development.

Analysis of Harvesting Cost

Harvesting costs are inextricably bound to the economics of the industry, which in turn is part of a much larger economic sphere. General Canada-wide increases in all costs are causing increases in harvesting costs. Cost increases have successfully been passed on to purchasers of forest products in the past. The Forest Service is in effect predicting that harvesting costs can be born by forest industries with margins remaining for profit, industry growth, and fulfillment of land management obligations. Analysis of this premise requires first an analysis of current extraction costs.

Appendix III-10 contains detailed estimates of current costs under varying conditions on the project area. Appendix III-11 shows that approximately 1,043 people are currently employed in woods operations (this number will soon be augmented by full scale operations of PG). The cost estimates are the results of combining these manpower costs, known rates of production, and associated equipment and capital costs. The table below summarizes these costs for each type of operation. Procter & Gamble, a major contributor to overall costs, is also an unknown factor at present. The assumption is made that the PG cutting and skidding costs, using Caterpillar Harvesters, will parallel those of NWPP, all other factors being equal. Procter & Gamble will retain the option of reverting to the conventional cutting systems if Harvesters prove too costly to operate. Procter & Gamble loading and hauling costs will be similar to those of other operators, given similar hauling distances.

The calculated 1973 costs of wood delivery and related forestry costs under current requirements are as follows:

	Volume cunits	Stumpage $/cunit	Operating Cost $/cunit	Total Cost $/cunit
NWPP	323,000	3.09	28.28	31.37
NCFI	200,000	9.50	31.46	40.96
PG (1973)	200,000	1.97	30.43	32.40
Others	68,000	9.50	27.76	37.26
Combined	791,000	4.98	29.58	34.56

These estimates are generally confirmed by interviews which were held with the operating companies.

Based on inquiries and current trends, it is projected that woods wages will increase at a rate of 8 percent per annum and machinery and materials at 6 percent per annum; but that stumpage and interest will not increase in the short run. The compensating effect of increasing distances, the increasing proportion of pulpwood cut, and the possibility of reduced stumpage on high cost areas are considered. In combination, these increases produce an overall 5.6 percent annual rate of increase in total wood costs (see Table 3.13).

Similar increases in the value of forest products can be predicted. Some investigators predict lower annual percentage increases (e.g., Cauvin, 1970, suggests a 3 percent annual increase for pulp and a 5 percent annual increase for lumber). However, vigorous present demands for lumber, pulp, and plywood lead to the firm conclusion that the margin between selling price and cost will remain consistent over the next 5 years, if not longer. The probability of increasing productivity per man or machine hour in the woods adds a safety factor.

Availability of Surplus Harvesting Funds

Detailed financial analyses of individual operations are beyond the scope of this project. Based on local investigations and previous analyses, however, the following approximate relationships between costs and revenues in the industry are set forth, and are summarized in Table 3.14. The premises for this analysis are:

1. Current average selling prices, f.o.b. plant, are in the order of $175.00 per air-dried ton of bleached kraft pulp, and $130.00 per M B.M. of lumber. It is expected that prices

TABLE 3.13

PROJECTION OF HARVESTING COSTS ON PROJECT AREA

COMPONENT	WAGES	MACHINERY	FIXED	TOTAL
EST. ANNUAL INCREASE	8%	6%	0%	(5.6%)
	(COST IN $/C C.F.)			
1973	$10.55	$17.64	$6.37	$34.56
1974	11.39	18.70	6.37	36.46
1975	12.31	19.82	6.37	38.50
1976	13.29	21.01	6.37	40.67
1977	14.35	22.27	6.37	42.99
1978	15.50	23.61	6.37	45.48

will fluctuate around this level during 1973 and 1974, and will generally rise thereafter.

2. Current costs are as indicated.

3. Before-tax returns on average capital investment, for the long-term health of both the lumber and pulp industries, must be in the neighborhood of 20 percent per annum.

Based on these and further assumptions, Table 3.14 indicates before-tax returns in the order of 21.3 percent currently in the pulp industry, and 23.5 percent currently in the prospering lumber industry. After-tax returns would of course be much lower, in the order of 8 or 9 percent. Analysis of plywood returns is not attempted, but rather these are considered along with lumber returns.

If it were considered reasonable to allocate returns in excess of 20 percent to extra forestry and environmental expenditure, Table 3.14 indicates that:

- Pulp Operations: Protective measures costing an extra $2.30 per cunit could be undertaken;

- Lumber Operations: Protective measures costing $2.20 per cunit could be undertaken.

These are relatively small residual values, calculated for present circumstances and based on admittedly tenuous average values. Some part of the surplus income indicated in this analysis would currently be available for increased forest management and environmental expenditures.

ESTIMATE OF SURPLUS FUNDS WHICH COULD CURRENTLY BE RELEASED FOR EXTRA ENVIRONMENTAL PROTECTION

	1973 STATUS		1973 STATUS IF BEFORE-TAX RETURNS LIMITED	
	PULP	LUMBER	PULP	LUMBER
Average Investment, Woods and Plant	$125,000,000	$20,000,000	$125,000,000	$20,000,000
Annual Wood Requirements, C C.F.	711,546	316,815	711,546	316,815
Investment per Cunit	$175	$63	$175	$63
Before-tax Annual Return on Investment	Unrestricted	Unrestricted	20%	20%
Net Selling Price f.o.b. Plant	$175/A.D.T.	$130/M B.M.	$175/A.D.T.	$130/M B.M.
Net Selling Price per C C.F. (170 cf./ADT., 167 cf./M B.M.)	102.95	78.00	102.95	78.00
LESS ESTIMATED COSTS:				
Harvesting Including Stumpage	30.65	39.10	30.65	39.10
All Other Costs	35.00	24.10	35.00	24.10
Surplus Available for Extra Expenditures	0.00	0.00	2.30	2.20
TOTAL COSTS PER C C.F.	65.65	63.20	67.95	65.40
PROFIT PER C C.F.	37.30	14.80	35.00	12.60
BEFORE TAX RETURN ON INVESTMENT	21.3%	23.5%	20.0%	20.0%

The lumber market is currently strong; the pulp market is strengthening following a weak period. Future markets will rise and fall, but it will be necessary for each operating company to satisfy annual forestry and environmental obligations independently of market fluctuations.

Appraisal of Extra Costs Associated with New Cutting Practices

The "6 to 8-foot, 20-year Rule" will be applied widely from now on. The possible consequences of this rule are illustrated in Figure 3.1. Case S (short, 20-year cycle) is attainable if restocking of the first-cut blocks successfully attains a height of 6 to 8 feet within 10 years of cutting. Case L (long, 30-year cycle) is the sequence of cutting necessary if height growth of this order is unsuccessful for the full maximum of 20 years following cutting. Figure 3.1 illustrates the cutting sequence under Case S and Case L for one of several 5,000-acre pine "sides" or subdrainages divided into twenty 250-acre blocks.

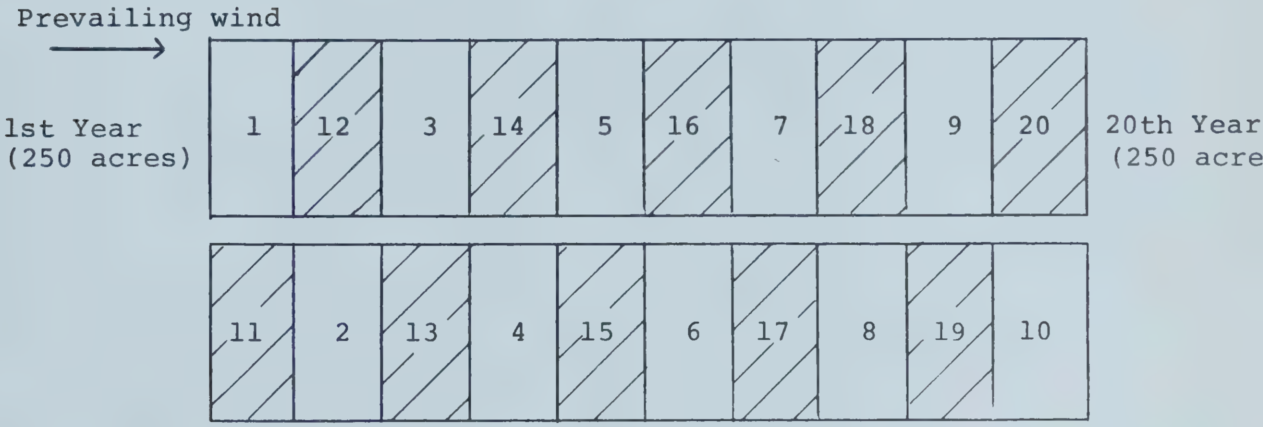
No differences between the two cases in felling, skidding, or hauling costs are foreseen. The major difference is associated with the road construction costs remaining unamortized. In Case L the road system required to develop the block must remain 50 percent amortized for an additional 10 years before complete amortization can take place in the third decade.

A second important feature in the Ground Rules will restrict the width of clearcut blocks under certain conditions of species or terrain. Cutting on narrow strips has generally been the practice in spruce types, but will be extended to include pine types on steep slopes under the new Ground Rules. The cutting of large blocks will be designated Case B (blocks); the cutting of narrow strips will be designated Case N (narrow strips). See Table 3.15.

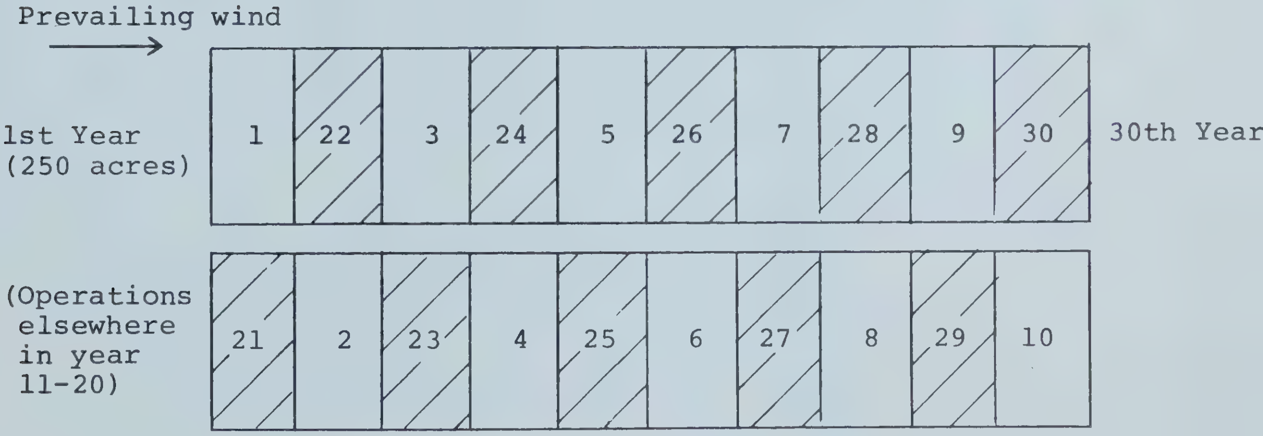
FIGURE 3.1

DIAGRAM OF 20-YEAR AND 30-YEAR CUTTING CYCLES
(one of several 5,000-acre pine "sides" divided
into 20 250-acre blocks)

CASE S 20-Year Cycle - 10 Years Elapsed Time Between Adjacent Cuts


Prevailing wind
1st Year
(250 acres)
1
12
3
14
5
16
7
18
9
20
20th Year
(250 acre
11
2
13
4
15
6
17
8
19
10

CASE L 30-Year Cycle - 20 Years Elapsed Time Between Adjacent Cuts


Prevailing wind
1st Year
(250 acres)
1
22
3
24
5
26
7
28
9
30
30th Year
(Operations
elsewhere
in year
11-20)
21
2
23
4
25
6
27
8
29
10

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The cost differentials associated with combinations of these four cases are estimated below. Ordinarily Case S and Case B would be expected to produce the lowest harvesting costs, and Case L and Case N the highest harvesting costs.

Appendix III-12 is a detailed year-by-year analysis of road amortization under Cases SB, SN, LB, and LN. The premises upon which this analysis is made are stated. All projections are based on level or rolling ground, but it was demonstrated separately that amortization cost of developing alternate spur roads traversing steep slopes, with subsequent construction of the intervening second-cut spur roads, is similar to that developed under Case N.

The analysis is for a hypothetical pulpwood operation, starting in a new area. In this respect it is similar to PG, and to NWPP's second, third and fourth cycle areas free of past cutting. The cost of unamortized road is expressed in the form of interest at 8 percent per annum on costs not yet written off by harvesting. A differential in road maintenance cost on the immediate cutting area is anticipated between Cases B (blocks) and N (narrow strips). No differential is allowed between Cases S and L, since maintenance would be negligible on an operating area during any waiting period between first and second cuts.

Results are summarized in Table 3.15. This indicates that road amortization and maintenance for short cycle and large blocks (Case SB) will average about $1.07 per C C.F. The added cost associated with longer cycles is either $0.35 or $0.55. The added costs associated with narrow strips is either $0.27 or $0.47. The combined additional cost of both longer cycle and narrow strips is $0.82.

ESTIMATED EFFECT OF CYCLE LENGTH AND CLEARCUT SIZE ON ROAD CONSTRUCTION AND MAINTENANCE COSTS

(FROM APPENDIX III-12)

CLEARCUT SIZE \ CYCLE LENGTH		S (SHORT CYCLE)			L (LONG CYCLE)		
		Cycle Year	Interest on Unamortized Roads $/C C.F.	Road Maint. Cost ** $/C C.F.	Cycle Year	Interest on Unamortized Roads $/C C.F.	Road Maint. Cost ** $/C C.F.
B (LARGE BLOCKS)	Lowest Year	2	0.50	0.16	2	0.50	0.11
	Highest	11	1.27	0.33	21	2.13	0.34
	Weighted Average	-	0.83	0.24		1.20	0.22
	Int. & Maint.			1.07			1.42
N (NARROW STRIPS)	Lowest Year	2	0.54	0.16	2	0.54	0.11
	Highest	11	1.69	0.43	21	2.98	0.47
	Weighted Average	-	1.04	0.30		1.60	0.29
	Int. & Maint.			1.34			1.89

AVERAGE COST DIFFERENTIALS ($/C C.F.):

1. Due to Cycle - LB - SB - $.35
   LN - SN - .55
2. Due to Size - SN - SB - .27
   LN - LB - .47
3. Due to Both - LN - SB - .82

Annual Interest @ 8% on unamortized cost of roads built

**Calculated at $.30/C C.F. cut per 300 miles of road in Case S, and $.20/C C.F. in Case L

The industry has opportunities to maximize the occurrence of Case SB, reduce Cases SN and LB, and minimize Case LN. It is felt that a 60-15-15-10 percentage relationship between these respective cases should prevail for several decades. The weighted cost overall is then calculated at $1.24, and the incremental cost over universal cutting under Case SB at $1.07 is therefore $0.17 per cunit.

This analysis indicates that the overall unit cost of extra expenditures resulting from the new Forest Service requirements would not encroach significantly on the expected profitability of the industry in coming years.

3.3.5 Watershed Stabilization on Cutovers

The Ground Rules state that not more than 50 percent of the area of merchantable timber shall be operated in any one cut. This rule is interpreted to apply within compartments, roughly equivalent to subwatersheds. It is further interpreted as removal of 50 percent of the merchantable timber over the first 10-year cut, followed immediately (subject to restocking requirements) by removal of the remaining 50 percent of the original volumes during a second 10-year cut. In a case where the subwatershed was originally timbered completely and revegetation to a stage acceptable for watershed stabilization took 10 years, the unstabilized area would rise to 50 percent in the tenth year and remain at this level until the twentieth year. Devegetation of a watershed would not normally be this extreme, because of the presence of unmerchantable areas, and because revegetation is normally more rapid. There is nevertheless some doubt whether the existing rule can entirely prevent watershed deterioration in all cases.

A more positive safeguard against watershed deterioration, suggested by practices used in mountainous forests of the Western United States, is as follows:

a. Define adequate vegetation for watershed stabilization (e.g., percent vegetative coverage determined from aerial photography).

b. Set a minimum percentage of total subwatershed area which must qualify as stabilized under this definition. The suggested percentages are 90 percent for subwatersheds of "H" sensitivity (Watershed Overlay, Volume 2); 80 percent for "M", and 60 percent for "L".

c. Require that the appropriate percentage of stabilized area be maintained at all times within the subwatershed.

"Revegetation" unlike "restocking" can, of course, consist of grass, brush, trees, or any other plant forms which adequately stabilize the surface soil. Table 3.16 illustrates the need for prompt revegetation of watersheds in order to permit harvesting on the schedule proposed. Revegetation within two years of cutting permits cutting to conform with the 90 percent criterion in all cases. Four-year revegetation allows cutting if the merchantable stands to be cut comprise up to 50 percent of the watershed area, but otherwise requires that some stands be left uncut or that the cutting period be lengthened. Ten-year revegetation permits the accumulation of more unstabilized surface than would be tolerable under this criterion, unless no more than about 20 percent of the watershed is timbered and designated for cutting.

A recommendation for adoption of this rule, including a suggested definition for adequate revegetation, is given in Chapter V.

TABLE 3.16

EFFECT OF REVEGETATION TIME ON CLEARCUT CYCLE TO MAINTAIN 90% VEGETATION ON A 24,000-ACRE WATERSHED

WATERSHED LAND ACREAGE (AC.) (A)	YEARS TO REVEGETATE CLEARCUTS (B)	% OF AC. WITH MERCH. TBR. % (C)	MERCH. AC. (AC.) (D)	PERMISSIBLE CUTTING TO MAINTAIN 90% COVER		
				PERMISSIBLE AC. CUT PER YEAR (AC.) (E)=.10 A/B)	TIME TO COMPLETE BOTH 1ST AND 2ND CUTS (YRS.) (F)=D/E	MINIMUM LENGTH OF 1ST OR 2ND CUT (YRS.) (G)
24,000	2 years	100	24,000	1,200	20	10
		75	18,000	1,200	15	7.5
		50	12,000	1,200	10	5
		25	6,000	1,200	5	2.5
24,000	4 years	100	24,000	600	40	20
		75	18,000	600	30	15
		50	12,000	600	20	10
		25	6,000	600	10	5
24,000	10 years	100	24,000	240	100	50
		75	18,000	240	75	37.5
		50	12,000	240	50	25
		25	6,000	240	25	12.5

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3.3.6 Suitability of New Timber Crops as Game Habitat

New cutovers of dense coniferous stands are barren of vegetation for a brief period. After about five years of revegetation, however, they obviously provide excellent browse for deer, elk and moose. Still later, say at fifteen years, they provide both browse and cover. Grass, willow, aspen, and other non-coniferous cover play a vital role in providing browse and cover in early developmental stages of the new stands.

Table 3.17 illustrates the use of regenerating cutovers and adjacent timber by ungulates. The transect data were collected in the spring, and reflect game use during the previous winter. They show that:

- Browse is most abundant on mixedwood cutovers, and least abundant on pine cutovers. Even on these, however, available vegetation is browsed.

- Some ungulate winter use takes place as little as two years following cutting, but is probably based on vegetation which predates cutting.

- The pattern of feeding on cutovers and sheltering in adjacent mature stands is confirmed.

- Centers of large cut blocks are not browsed as heavily as edge areas. Centers of equally large residual blocks are also less heavily used for shelter.

- Strip-cut areas (while residual strips remain uncut) appear highly suitable.

- The only conifer consistently browsed is alpine fir, and even fir trees suffer only temporary retardation from loss of branch tips.

The critical period for ungulates occurs upon removal of residual timber blocks or strips in the second cut. The main purpose of the "6 to 8-foot, 20-year Rule" is the provision of some sheltered habitat replacing that removed in this period. This rule contains presuppositions that the locality in question is important game habitat, and that alternate shelter in the form of uncut deciduous, immature, or unmerchantable stands is absent.

The "6 to 8-foot, 20-year Rule" applies to any vegetation on a cutover, including advance conifer regeneration and poplar suckers. Poplar suckers attain a height of 6 feet within only a few years. NWPP experience from naturally seeded pine indicates average attainment of 6-foot dominants at from 9 to 12 years following germination. Height growth of spruce and fir is normally much slower during the first decade. The required habitat conditions will not normally be attained in 10 years in pure stands of these species. It is fortunate that aspen is often associated with them, if the rule is to be effective. This Rule will aid in retention of game habitat generally, but could be improved upon by standards which are more sensitive to local game management needs, and which recognize alternative habitat not affected by cutting plans. A recommendation for modification of the "6 to 8-foot, 20-year Rule" based on this reasoning is made in Chapter V.

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Table 3.17

UTILIZATION OF CUTOVERS AND ADJACENT TIMBER BY UNGULATES

(Transect Sampling in Hinton Area, Spring at 1973)

LOCALITY	ORIGINAL FOREST	YEARS SINCE CUT	CUT PATTERN (BLOCK/STRIP)	POSITION SAMPLED*	BROWSE SAMPLED AVAIL.	BROWSE SAMPLED SPECIES	BROWSE SAMPLED % UTILIZ'N	PELLET GROUPS PER CHAIN OF TRANSECT	REMARKS
Athabasca W.C.	Climax Spruce	5	Block	R-C	Nil	-	0	0	Some browse in cutover would be hidden under snow
				R-E	Mod.	Willow	0	.1 Moose	
				C-E	Common	Willow	10	.1 Moose	
				C-C	Mod.	Willow	10 - 70	.2 Moose	
McLeod W.C.	Climax Spruce	11	Strip	R-C	Scant	Willow and red osier Dogwood	30	.1 elk, .1 deer	Feeding in cutover, bedding in residual timber
				R-E	Scant		30	.1 moose	
				C-E	Common		50 - 60	-	
				C-C	Common		50 - 60	-	
Athabasca W.C.	Spruce-Pine	8	Block	R-C	Nil	-	0	.4 deer, .1 moose	
				R-E	Nil	-	0	.3 deer, .2 moose	
				C-E	Common	Spirea, Willow, Alder	40	-	C-E heavily browsed
				C-C	Common		0	-	
McLeod W.C.	Spruce-Pine	11	Block	R-C	Scant	-	0	.1 deer, .2 moose	
				R-E	Scant	Willow	20	.5 moose	
				C-E	Common	Alder	80 - 90	.1 elk, .5 moose	C-E heavily browsed
				C-C	Common	Willow	0 - 50	.1 moose	
McLeod W.C.	Pine	2	Block	R-C	Nil	-	0	-	Two years after cutting, browse on cutover has developed
				R-E	Nil	-	0	.1 deer	
				C-E	Scant	-	0	.1 deer	
				C-C	Scant	Willow	0 - 70	1.8 Horse	
Marlboro W.C.	Mixed-Wood	6	Block	R-C	Abund.	Willow, fir	20 - 100	-	Tracks common, pellets difficult to detect under ground vegetation
				R-E	Abund.	Willow, aspen	10 - 40	-	
				C-E	Abund.	Willow, aspen	30 - 90	-	
				C-C	Abund.	Willow	20	-	
Marlboro W.C.	Mixed-Wood	9	Block	R-C	Abund.	Willow, aspen	0	.2 deer, .4 moose	Abundant browse in residual stand was disregarded in favor of cutover browse
				R-E	Abund.	Willow, aspen	0		
				C-E	Dense	Willow, aspen	20 - 80	-	
				C-C	Dense	Willow, aspen	20 - 80	-	

* R-C - Residual timber, Centre
R-E - Residual timber, Edge
C-E - Cutover, Edge
C-C - Cutover, Centre

3.4 Regeneration and Silvicultural Practices

This phase is in many ways the "acid test" of forest management. Without new timber crops developing promptly, sustained yield forestry commitments would be gradually invalidated. In addition, maintenance of a forested setting lies at the heart of virtually every environmental objective that can be set for the project area.

3.4.1 Restocking Objectives and Standards

The standards set by the Forest Service are clear, and create unmistakable obligations for forest managers in both industry and Government.

Each cutover block must be examined before the seventh year following cutting, and if not satisfactorily restocked (NSR), it must be treated appropriately to insure adequate restocking within the final years of the 10-year allowable regeneration period. The standards by which a cutover is judged satisfactorily restocked (SR) are clearly stated in Sections 131-138 of the Timber Management Regulations (see Appendix III-13). These apply specifically to quota holders, but are also applicable to FMA holders.

The details of regeneration survey methods are described in the Forest Service Regeneration Survey Manual (1971).

Comments based on field observations and discussions are as follows:

a) The basic criterion for an SR area is 40 percent milacre stocking, implying presence of at least 400 well distributed, commercially valued trees per acre. This standard was arbitrarily chosen by the Forest Service some yea ago, and is not supported by research, but appear generally correct for the major species under most conditions. Insistence on denser stocking might produce less utilizable volume at rotation age. Stocking standards could by now have been based on more quantitative results in the form of continuing spacing trials. These are inexpensive to establish on well stocked cutover land by removal of seedlings surplus to the spacing being tested. Both spacing trials and information relating milacre stocking to absolute stocking in trees per acre would provide a needed basis for selection of multiple standards for varying conditions. Of those observed, many cutovers exhibited restocking close to the official 40 percent limit. A small change in this limit upwards or downwards would therefore be far-reaching.

b) The Forest Service standards exhibit bias toward the preferred conifers and against balsam fir and poplar. This bias has been justified on the basis of utilization and values, but is obsolete now for balsam fir, and may require modification in future for poplar.

c) These standards may be conservative in defining an established tree as one growing at least three years on site (or two trees, each two years on the site). Without firmer evidence on survival after two years, however, this rule remains justifiable. Germinates (yearlings) are not considered established. It has been suggested that three germinates could be equated to one established tree. This principle is theoretically sound, but the precise number of germinates which are the equivalent of one established tree is open to question. Perhaps the presence of germinates could be interpreted as support for delaying a planting operation for an additional year.

d) The regeneration survey method provides 1.667 one-milacre samples per acre of cutover. This intensity gives adequate coverage of the clearcut area, and costs an estimated $0.50 per acre. Local intensification of sampling would be necessary if the rules regarding treatment of 10-acre NSR areas within the cutover are to have statistical significance. On the other hand, a reduced intensity should be permitted on lands obviously stocked or obviously unstocked. Various forms of sequential sampling might reduce total survey costs, or permit intensified sampling with greater likelihood of correct decisions on areas of marginal stocking. The tests of color photography by NWPP to distinguish SR and NSR areas are of interest. However, to date only large seedlings can be seen. It would appear that planting decisions would in many cases be necessary before results from photo interpretation would be obtainable.

3.4.2 Restocking Behaviour of the Major Species

It is certain that the principal species present are well adapted for survival on the project area under natural conditions. However, each has favorable and unfavorable characteristics under the less natural management system in use. These can be summarized briefly as follows:

White Spruce

Favorable:

- high commercial value and growth potential;
- tolerance to moist, cool sites;
- tolerance to vegetative competition, and response to release.

Unfavorable:

- infrequency of adequate seed crops;
- no precocious seed-bearing;
- no storage of seed in cones as is the case with lodgepole pine;
- slow initial growth;
- intolerance to exposure or drought (shallow rooting habit);
- susceptibility to fire-killing and wind-throw.

Black Spruce

Favorable:

- good pulping characteristics;
- ability to thrive on muskeg or poorly drained sites;
- good reproductive capacity by seed flight, serotinous cone storage, and layering.

Unfavorable:

- slow growth to merchantable size;
- inability to compete on mesic sites.

Lodgepole Pine

Favorable:

- high commercial value and growth potential;
- perennial seeding capacity through serotinous cone habitat and precocious seed-bearing;
- rapid initial and sustained growth;
- tolerance to drought and exposure (deep rooting).

Unfavorable:

- intolerance to shade;
- tendency to stagnate if over-stocked.

Poplar

Favorable:

- capacity for vegetative regeneration and extremely rapid early growth;
- tolerance to exposure (a pioneer species);
- value as a nurse crop for spruce regeneration.

Unfavorable:

- marginal commercial value to date in region;
- early decadence.

Balsam Fir

Favorable:

- shade tolerance and response to release;
- deep rooting habit.

Unfavorable:

- susceptibility to browsing, spruce budworm infestation (with spruce as a secondary host), injury and decay.

Unlike conditions for regeneration elsewhere, those of the project area are relatively unforgiving. Silvicultural errors will sometimes require a full rotation or longer to remedy. In addition, the financial returns realizable from harvesting of each acre restrict levels of silvicultural expenditure more severely than elsewhere.

Recognition of these facts even before cutting is necessary, so that cut planning will not create excessively difficult regeneration chances. The choices provided by new ground rules and the opportunities for review of planning through A.O.P.'s are important to permit concentration of expensive restocking methods on small acreages.

The cutting patterns called for by ground rules are theoretically sound, but may require local modification after results are observed. One interesting proposal to alter the pattern has been introduced by NWPP. It is known as the Progressive Clearcut Method, and briefly it would involve:

- application to a single compartment as a unit, to be clearcut over a 20-year period as usual. The NWPP proposal originally was for conversion to the Progressive Clearcut System over the entire lease area;
- development of all main roads initially;
- clearcutting of timber in a continuous, moving "strip", with no retention of 2nd cut blocks, other than to provide game corridors;
- scarification and regeneration to standards set, including large-scale planting if needed, followed by removal of most roads as soon as restocking is secured.

Advantages in compactness and ease of control on operating areas and preclusion of windfall losses would offset heavy initial road investments. Environmental and habitat impairment might be caused by creation of uninterrupted clearcuts.

This proposal has been rejected to date by the AFS, but might prove advantageous on certain well-chosen single compartments. It would have neither adverse effects nor important advantages where mature stands were small in acreage and widely separated by immature or deciduous stands.

3.4.3 Regeneration Techniques

1. Unaided Natural Restocking

Harvesting itself is classically considered as a regeneration technique. Clearcutting systems described above are designed to achieve restocking, with or without additional help, on a high proportion of cutovers.

Artificial aids are applied where natural means are deemed likely to fail or to create an unacceptable delay.

The first technique for review is therefore clearcutting unaided by other treatment. This has little promise on spruce sites except where:

- a healthy understory of desired species already exists and has not been damaged by skidding;

- acceptable seedbed conditions exist;

- adequate viable seed is available when needed from marginal or residual seed bearing trees. This seed must be adequate to overcome natural mortality and losses to rodents or to other agencies;

- unwanted vegetation does not usurp the site, but sufficient live or dead shade is present for protection of spruce seedlings from the elements;

- climatic conditions are favorable during germination and early development.

Unaided clearcutting has considerably more promise on lodgepole pine sites, but is still limited at times by lack of mineral soil and the failure of cones suspended above the ground to open. McDougall and Kennedy (1971) reported that, of an estimated 35,000 acres of untreated cutovers on the NWPP lease, approximately 75 percent, or 26,000 acres required no treatment. These restocked areas are largely pine sites or spruce sites with heavy advance understory stocking.

The various classical methods for partial removal of a stand, with reseeding from the residual overstory, are unlikely to gain favor except where watershed or aesthetic considerations outweigh the usual need for economy. However, these exceptions will be increasingly common, for example in the protective strips surrounding watercourses and lakes. These techniques are silviculturally and environmentally sound for spruce and other tolerant species, but are less certain for pine. Diameter-limit cutting has produced acceptable spruce restocking on old winter sawlog operations, but unaided restocking of modern clearcuts is considered too uncertain for most future operations.

2. Scarification

Well executed scarification following skidding has three desirable effects:

- fire hazard is reduced by suppression of the slash layer;
- pine cones, which require heat to open and release seed, are immediately brought close to the ground where this heat is applied:
- a seedbed of mineral soil, free from immediate competing vegetation, is provided.

A Forest Service standard based on experience is that 60 percent of a series of milacres sampled should have at least one square foot of exposed mineral soil for successful restocking under the requirements. With machines, this normally requires about 40 percent surface disturbance on a good distribution pattern. Most scarified sites observed (pine or spruce sites) appeared to satisfy this standard, and yet were free of any threat of sheet erosion.

Scarification is a highly mechanized process capable of covering large areas quickly. Approximately 70 percent of all NWPP clearcuts are scarified, with lesser proportions on the clearcuts of the other companies. Scarification usually follows cutting closely, in order to take early advantage of pine or spruce seeding potential. From observations, a high percentage of scarified pine cutovers, perhaps 80 percent, have restocked promptly and satisfactorily on the NWPP lease, where this practice was first used almost 20 years ago.

Reliable regeneration survey data for the large areas treated by scarification are difficult to obtain or interpret precisely. NCFI survey results (largely unscarified land) between 1958 and 1970 are summarized in the NCFI management plan. These indicate 84 percent SR on 6,392 acres surveyed. More recent data from 1971 and 1972 surveys, apparently covering much of the total area cut by NCFI since 1964, indicate 65 percent SR out of 14,250 acres surveyed on the FMA and 100 percent SR on the 1,087 acres outside the FMA. Even areas cut as recently as 1970 indicate 47 percent SR, which must indicate substantial cover by advance regeneration. These data indicate considerable restocking success, probably influenced by past sawlog utilization practices and the protection of understory conifers which would occur with winter harvesting.

By observation alone the restocking of NWPP scarified cutovers approaches the order of 80 percent after five or six years elapsed time, with exceptions noted in the Camp One (Brule Lake) area and a limited acreage along the Gregg River. McDougall and Kennedy (1972) state that "scarification techniques utilizing heavy drags are 81 percent effective in obtaining regeneration to the required standard within seven years on pine sites".

The methods and equipment used for scarification have been the subject of much experimentation. Two main types have emerged:

Pine Sites

These generally occur on upland, well drained, non-organic soils. Scarification is often delayed over summer to permit slash to become brittle since this aids the scattering of cones. D6, D7 or equivalent tractors, equipped usually with toothed or V-shaped blades of various designs, traverse the area along contours. The blade may remain down but is often raised and lowered for the deflection of debris. The addition of heavy drags, constructed of old tractor rails, anchor chain, or fluked drums in tandem, has been an effective supplement to blading in the crushing of slash and the distribution of cones.

Spruce Sites

These occur on clayey or silty soils, and often have heavy accumulations of undecomposed litter. Decadent spruce-fir stands produce abnormally heavy debris when cut. The methods used on pine sites often do not expose underlying mineral soil under these conditions. Deep blading of the type observed on the Athabasca Working Circle of the NWPP lease has been developed for these conditions. Both standard and specially designed blades are used. One newly developed blade is fitted with three spaced ploughs capable of creating three furrows approximately one foot deep during each pass. The examples of recent blading observed were probably done with a straight angled blade. Windrows of deflected litter and slash were often as high as four feet. Furrow centers tended to be glazed hardpan, or to contain ponded water which would persist during the growing season. The scarified furrows present a range of seedbed conditions from mixed litter and mineral soil at the edge to pure subsoil at the center. Conditions are optimal near the edges of the furrows. Most of the blading seen was continuous for drainage purposes, but the practice of alternate blading and skipping has been tested, and may prove superior on some sites.

It is important that the machine bypass any appreciable clumps of undamaged spruce or fir regeneration. It is the practice also to leave clumps of standing poplar undisturbed, since this prevents stimulation of suckering. Since the spruce and balsam fir cones are non-serotinous, unlike pine cones, scarification of these sites must be followed promptly by natural or artificial seeding or planting, before brush or grass reinvades the area.

Scarification by methods appropriate to the site is regarded as a basic and necessary reforestation treatment on most clearcuts. Many pine sites will restock with no further treatment.

The use of Caterpillar Harvesters may reduce the intensity of scarification needed, since these machines appear to disturb the ground more evenly and more widely than power saw-skidder combinations. Procter & Gamble foresters are considering the possibility of dispensing with scarification entirely or using light drags behind rubber-tired skidders, on sites harvested in the spring of 1973.

3. Slash Burning

Slash burning has been used less extensively than elsewhere, but may be necessary for reduction of fire hazard on slopes too steep for scarification (perhaps over 30 percent slope). On these steep slopes, burning will destroy much of the pine seed in the slash, necessitating artificial reforestation, but will provide suitable seedbed conditions in almost all cases. It will be necessary to guard against the danger of escapement into surrounding timber, by the construction of fire-guards along cut boundaries, and by judicious timing of burning operations.

Several examples of the use of fire on lowland and level sites were observed. These appeared to be less positive in securing regeneration than mechanical scarification. The burned acreages were small and perhaps only hot enough to destroy pine seed without creating good seedbed conditions on a wide scale. Artificial seeding was done subsequent to burning on some of these areas, but was not notably successful except on skid roads. From appearances, burning had stimulated aspen suckering even more than scarification would have.

4. Artificial Seeding

This technique has been tested widely in North America, but has never remained a main-stay of reforestation programs. The principal arguments against aerial seeding in preference to planting are the expense of greatly increased seed requirements per acre restocked, the seed losses to rodents (failing the use of pesticides), the wastage of seed falling on unsuitable ground, and the lack of spacing control in the new stands. Some of these obstacles can be overcome with ground seeding either on prepared spots or broadcast, but it has usually been considered that the advantages of planting outweigh even ground seeding.

Hellum (1973) describes extensive artificial seeding operations in Alberta between 1960 and 1971, totalling 103,970 acres seeded by the AFS and 8,530 by industry. Some 24,000 acres of this were within the project area. No other Province in Western Canada even remotely approaches this level of seeding application. Seeding in Alberta has been roughly 10 percent from helicopters with the remainder ground broadcast seeding with cyclone seeders or hand sowing. Emphasis was properly put on spruce sites lacking the cone storage of pine sites, and over 80 percent of all seeding projects were with white spruce or mixed spruce and pine seed. Seeding was done in all seasons but most commonly in fall, winter or spring.

Results for this intensive program have been "poor", based on regeneration surveys of 174 individual projects. Only 4 percent were SR by AFS standards, and only 17 percent exhibited coniferous stocking on 20 percent or more of milacres sampled. Volunteer deciduous stocking was apparently more successful than the seeding done on these projects.

All of the major companies of the project area, particularly PG and NCFI, intend to rely rather heavily on scarification and artificial seeding in their reforestation programs. This is particularly true in NCFI cutovers, which presently lack convenient access for planting. If future results are no better than those reported by Hellum, these programs will be virtually worthless, and the area seeded will still require planting. Hellum attributes past failures to the use of inadequate quantities and qualities of seed, inadequacy of seedbed preparation, lack of care in seeding operations, and poor germination of summer or fall seeding. For future seeding, he implies that the following minimal guidelines will be necessary:

1. Seeding only in early spring on fresh snow (above the zone of rodent feeding).

2. Application of at least three times the quantity of seed applied per acre in the past (proportionately heavier applications would be required if the seed is of low viability).

3. Automatic checking of seeding success within a year, with immediate re-applications of seed where necessary. This promptness is important for the establishment of seedlings before the effects of scarification are diminished by grass or brush.

4. Emphasis on ground (usually snowmobile) seeding in preference to aerial seeding, with efforts to select favorable microsites.

At least moderate success in future seeding operations is almost mandatory on the project area, as a supplement to natural regeneration on spruce sites and as an alternative to planting. Hellum's conclusions are therefore fully endorsed.

There is one further possible technical improvement which might merit attention. Pelletization of seeds in clay, with or without a rodent repellent, might provide significant protection against rodents and prevent desiccation of germinates. Inexpensive pelletization is probably feasible, using equipment already in use for the mud-packing of seedlings.

Even with successful restocking from seedlings, it is extremely doubtful whether spruce restocking 6 to 8 feet tall will develop from seed in ten years, as required by the new "6 to 8-foot, 20-year Rule". This problem, not confined to seeding alone, is discussed elsewhere.

5. Tree Planting

Areas which have failed to restock to AFS standards naturally or through other treatment by the seventh year after cutting must be reforested by planting. The past negative results with seeding have already meant the placing of considerable reliance on planting. Successful planting programs will be essential for rehabilitation of old NSR under supplemental reforestation programs, for restocking of "hard-case" cutovers, and particularly for restocking of second-cut spruce sites lacking spruce seed sources (mainly of NWPP and NCFI concern to date).

Plantation Survival Experience

Froning (1972) provides the most comprehensive independent appraisal of Alberta planting performance available. His results for Alberta cover 90 percent of all areas planted in the years 1965, 1967, and 1970, cover both spruce and pine, and cover a range of site preparation conditions and planting techniques. Survival data one year, four years, or six years after planting are combined, although some mortality must be expected beyond the first year.

Froning's arbitrary standard for satisfactory restocking is 60 percent survival of planted trees (approximately 300 planted trees surviving per acre). Collective results for the project area indicate that 60 percent of the plantation area examined (1,784 out of 2,985 acres) had obtained this 60 percent standard or better. Individual plantations exhibited from 10 percent to 90 percent survival. Only 38 percent of the number of plantations examined (13 out of 34) met the standard, indicating superior success on a few large plantations, possibly because of site preparation. Further observations of Froning are:

- Higher success (discounting further mortality after the first year) for the 1970 plantations than for earlier work, common to both container and bare root planting. Improvements in techniques are inferred from this.
- Perceptibly greater success on Boreal Forest than on Foothills sites, attributed to the effectiveness of planting machines, and to climatic differences.
- Lack of success on inadequately prepared sites, regardless of planting technique.
- Frequency of suppression by weed species.
- Evidence of poor planting techniques and low grade planting stock.
- Evidence of frost heaving in container plantations (specifically Ontario-type tubelings).
- Human failures in planting, handling, and record keeping.

Examination of plantations of both the AFS and industry during this project tended to verify Froning's observations in all important respects. It is acknowledged that nursery and field techniques are steadily improving (one technique upon which the above results are partly based, the Ontario-type tubeling, is not used now). Anticipated mortality could theoretically be overcome by planting increasing numbers of seedlings per acre, but this approach is much inferior in terms of economy and spacing uniformity to improvements in the survival of the trees planted. Survival in the order of 70 percent or better, on a high proportion of plantations (say 90 percent) will be necessary before planting can be relied upon as a clean-up technique where all else has failed.

Disappointments in the results of reforestation efforts have commonly occurred at early developmental stages in other regions. For example, in California at a comparable stage, tree planting was regarded as an "unrewarding gamble" (Schubert and Adams, 1971). Plantation success ratios have since risen in California from a pre-1953 average of 31 percent to a current average of 85 percent, without unreasonable increases in cost.

Current Planting on the Project Area

The approximate scale of the 1973 planting program in the project area, based variously on seedling inventory, orders for stock, regeneration survey data, planting needs, and planting crews, is as follows:

	Acres to be Planted, 1973
AFS (Grande Prairie Forest)	1,000
AFS (Edson Forest)	300
AFS (Whitecourt Forest, W-1)	100
NWPP	4,000
NCFI	2,000
PG (1973)	nil
Other industry	nil
TOTAL	7,400

At 500 trees per acre, the commonly assumed density, this program requires approximately 3.75 million seedlings from AFS or private sources (NWPP is the only private producer of planting stock currently, but a private nursery has supplied stock to NCFI in the past and may do so again).

The planting program of PG will commence with its share of the Supplemental Reforestation program (1/2 of 1/20 of whatever area is

determined to be NSR on the lease).
In 1981 it is estimated that PG's planting program will rise rather suddenly to something in the order of 4,000 acres.

This 1973 program, involving 7,400 acres, results from rapid expansion in planting programs, since less than 4,200 acres were planted in 1970, 1,500 acres in 1967, and less than 700 acres in 1965, in the three forests of the project area (Froning, 1972).

Current performance apparently is still unsatisfactory. On AFS operations in the Edson and Grande Prairie forests, instances of faulty storage of bagged seedlings on the way to the site were noted. Access for planting crews was in one case severely limited. Even without faulty handling, AFS bare-root stock was of marginal size and vigor. The stock of best development seen was Spencer-Lemaire "plug" stock grown in the NWPP nursery. Some doubts about the success of planting even this stock were felt, however, since it appeared difficult at times to tamp the soil into close contact with each plug. The Potiputki planting tool was used in this case.

NWPP planting often includes planting of pine on upland spruce sites. This practice may be criticized on the grounds that it may further creation of a pine monoculture. These grounds are invalid. Planting is on a small scale and pine monoculture already exists naturally to a considerable extent. Mixtures of planted pine and natural spruce should result from this practice, and are highly desirable.

Planting crews seen in action were youthful, reasonably efficient and well motivated, and as is often true, newly trained. Since the perennial planter is still rare, the importance of developing a corps of experienced and competent foremen and supervisors is very great. Despite these critical comments, it is clear that planting sites are prepared better now than in the past, and that determined efforts to improve techniques are being made.

6. Nursery and Planting Techniques

a) Seed Supply

Viable pine seed can be extracted from cones collected from the tops of freshly cut trees, at any convenient time of year. Spruce cones must be collected within a limited period during good seed years, which occur approximately at 4 to 6-year intervals in the region. Gross genetic quality of seed of both species can be controlled by selection of the localities where parent trees are of satisfactory form. Seed extraction or storage is a less limiting factor in Alberta than elsewhere. The viability of fresh and stored seed is satisfactory. Sufficient seed can be supplied to sustain any reforestation program visualized for the project area, including both artificial seeding and planted seedlings. The cost of extracted seed from cones obtained locally averages approximately $10.00 per pound, considerably lower than commercial rates, but still high enough to discourage liberal use on large-scale artificial seeding operations.

b) Bare-root Stock

Traditionally bare-root stock is 3-0 (retained in the nurseries through three growing seasons, without transplantation before outplanting). One serious disadvantage of this technique is the necessity for knowledge of annual requirements at least 4 years in advance of seedling deliveries. The bare-root planting technique is so far at least as successful as container techniques, given proper care. It may well remain in use with planting machines, and has more promise than any other technique for fulfillment of height growth standards and for use on sites where brush is a threat.

Bare-root forest planting stock is presently produced, along with non-forest conifers and container stock, at the Provincial Tree Nursery at Oliver. The scale of production required for AFS planting and industry planting of AFS stock appears to justify development of AFS nursery facilities exclusively for reforestation. Sites are being considered by the AFS with this important object in mind. These sites may well be instrumental in improving the quantities and quality of planting stock beyond the standards reached in the past at Oliver.

Bare-root stock can be successfully grown by established techniques and successfully planted with planting bars or mattocks. "Mud-packed" bare-root seedlings have been tried in Alberta and used extensively in B.C. with considerable success under drought conditions. Late summer planting of suitably hardened mud-pack stock might succeed where normal stock would fail.

Two major problems noted with current bare-root stock are as follows:

- Size and vigor standards should be raised to avoid the futility and expense of outplanting stock with low survival prospects.

- Improvements in packaging, transportation, storage and handling of seedlings between the nursery and the planting site are required as noted above.

c) Container Stock

As noted, the Ontario-type tubeling is no longer used. Heavy mortality was experienced, probably due to the small volume of the rooting medium, inhibitation of root extension by plastic walls, and frost-heaving. The lessons learned led to development of plug-type plastic containers for growing in the nursery, which are removed just before planting, and of non-plastic containers which are permeable to extending roots.

All NWPP planting stock is of the Spencer-Lemaire plug-type, with soil capacity increased to about 4 cubic inches, and with vertical grooves designed to prevent the spiralling of roots noted in earlier types. For handling convenience, plastic "books" containing 6 seedlings each are used. Plantable seedlings can be produced in one growing season alone, but current practice is to overwinter seedlings for planting, resulting in approximately a one-year production cycle.

The NWPP production system appears relatively effective and economical. Improvements are probable in future, but will not fundamentally change the process.

A parallel container development, known as the Alberta Research Council Sausage, has emerged more recently, and is now produced at Oliver. Seedlings are grown in a cylindrical segment of thin plastic into which a peat rooting medium has been extruded. This has the advantage of highly mechanized preparation of containers ready for seeding. Still another system tested in Alberta is the rooting of seedlings in a porous "styroblock", in an attempt to avoid the cost of handling soil for containers.

Unpublished information from the CFS indicates comparable one year survival between the ARC sausage, the styroblock, and bare-rooted seedlings planted in July and August 1971 and checked in the summer of 1972. Survival differences over one year are not highly significant within any one site, but high incidence of frost heaving was noted for sausage stock.

Laboratory comparisons of seedling development, (16 weeks from germination) between the Spencer-Lemaire and ARC sausage stock are also available from the same source. In virtually every case, these comparisons favor the Spencer-Lemaire stock for both spruce and pine, in terms of dry weight attained, nutrient uptake, and root-shoot ratio. Differences are small but probably are significant in survival after outplanting.

A final container type apparently not yet tried in Alberta is the Japanese Paper Pot, heavily favored now in Scandinavia. This form of container is similar to styroblocks in shape, and thus less limiting than the others in capacity for lateral root growth. Most container systems are designed for convenience in outplanting. Packboard trays for containers and a variety of dibbles and planting tools have been developed. It is hoped by designers that these will remove some of the need for experience and care which attends bare-root planting.

It is clear that container plantations will be common in Alberta. All variations represent a gamble in comparison with the bare-root technique. Containerized seedlings retained too long before outplanting are believed to develop an inward-growing root habit which persists after planting and causes mortality after several years. There is extremely low probability that container stock in any present form can grow to six feet in less than ten years. CFS trials of Ontario tubelings indicate attained heights at 5 years from planting of 3 to 4 inches in spruce and 6 inches for pine. Later types may perform better but few planted seedlings observed appeared capable of meeting this height growth standard.

Container systems are being developed to overcome the obvious disadvantages of root disturbance, cost, labor requirements, and seasonality of traditional planting. In many cases it appears that desired results will be achieved, but the true criteria of planting techniques will remain cost per surviving seedling, acreage planted per year in relation to needs, and long-term performance of planted crops. None of these things can be known with much certainty for some time yet. In view of the variety of climatic, ground, soil, and growing conditions on the project area, it is probable that judicious combinations of most of the techniques available will be used.

7. Sheltering of Planted Seedlings

In the early stages, spruce seedlings require some shelter but not too much. Competing vegetation may provide this but may often compete too well. "Dead" shade, present as snags or debris on burns, is largely removed in scarification. Experimentation with various devices to provide dead shade has been considered useful but prohibitive in cost on any large scale. The prospect of outright failure of a spruce plantation and the necessity for replanting should give reason for further experimentation to provide dead shade. Once spruce seedlings are well established, "live" competition from aspen, alder and other vegetation is tolerated or even desirable on most sites.

Measures which should be tested for protection of plantations (or seed-spots) are:

- Location of seedling or seed-spot so as to be shaded by existing or piled slash, or by north-facing cuts created by blading.
- Development of expendable (e.g. corrugated board and wire) seedling "tents", probably capable of shading two sides for approximately five years. The alternative of re-using more durable devices is not attractive.

  These measures might provide critical early shelter on many pine sites, but would be of particular interest on spruce sites, and might be decisive on the extensive spruce clearcuts planned by PG.

3.4.4 Protection and Improvement of Timber Crops

Emphasis in silviculture on the project area to date has properly been placed on the re-establishment of new crops. Once these are established, however, several activities will be necessary for their protection or optional for their improvement. Funds for protection from serious threats must be forthcoming. Expenditures for improvements will be weighed against potential benefits and normally confined to the more productive sites. Mapping by site quality, such as that available in the NWPP lease, is the essential tool in allocation of major funds for these purposes.

1. Fire

Fire protection has been described elsewhere and is generally adequate. It is noted, however, that young stands will not supply seed for restocking, and thus will require artificial restocking if fire-killed.

2. Physiological Drought (Red Belt)

Chinook conditions periodically cause desiccation of needles or mortality in pine stands in belts at high elevation. Several cases of "Red Belt" involving heavy pine mortality occurred in the winter of 1972-73, and were clearly visible in the vicinities of Luscar and the upper Smoky and Kakwa River valleys. Where this has occurred in productive, accessible sites, and is expected to recur only rarely, special treatment for restocking is warranted, since it is not believed that seed will escape rapidly enough nor fall on suitable seedbeds for natural replacement. Where road development is present, prompt salvage cutting would ensure restocking. Prescribed burning has been proposed in more remote areas, but the danger of fire damage to surrounding stands is considered extreme.

3. Pests

The CFS has traditionally kept forest managers aware of forest insect and disease threats and will undoubtedly continue to do so. Conifers of the project area are not subject to serious decay damage until advanced ages are reached. Priority cutting of over-mature stands, as presently practised, will gradually reduce decay losses which are modest even today. Poplar decay normally sets in at young stand ages, and may render old stands unmerchantable within a few decades. The only preventative, cutting, is currently not applied. Several other disease organisms which cause deformation, loss of growth, or mortality are listed as present on the project area, but none appears a direct current threat at the level of management attained. Dwarf mistletoe and stem cankers of pine are common, but will not normally disrupt development of normal crops, and will be discouraged by the proposed cutting systems.

Several forest insects are listed for the project area, but again have not caused conspicuous damage to date. Spruce budworm, a defoliator which has caused widespread damage elsewhere in Canada, has been observed in Alberta, principally in the north. Alpine fir is its preferred host, but the threat of spruce mortality exists if insect populations exhaust the alpine fir. Massive budworm epidemics like those encountered in more moderate climatic zones of Canada are considered unlikely in Alberta. Yet the possibility of future budworm infestations in the project area cannot be dismissed, and some capability for control by salvage cutting must be kept open. Bark beetle epidemics in spruce are a possibility until over-mature spruce stands are replaced. The hylobius root weevil, feeding on pine seedling roots, may at times reduce stocking on plantations. The European pine shoot moth is regarded as a potential threat to pine seedlings throughout the west. The balsam woolly aphid is spreading, but Alberta's climatic severity appears to limit this threat, and the host, balsam fir is of secondary importance in the project area. Most forest epidemics are controlled by detection followed by removal of affected trees or stands. The potential for salvage will increase as development of the forest extends further.

Wild-horse occupation is locally inhibiting reestablishment of coniferous crops as well as maintenance of erosion-proof grass cover. Conflicts are fortunately localized, but can only be resolved by land use decisions accompanied by zoning and, in extreme cases, fencing.

4. Stand Improvement

Applications of chemical fertilizer for increased yield on the project area have not been successful, but should not be discounted under specialized circumstances in the future.

By controlling the spacing of immature stands, maximum utilizable volume can be attained at rotation age. This could be an important source of extra yield in the region, where overstocking, particularly in pine, often retards merchantable growth. Commercial thinning, considered feasible elsewhere, would currently be difficult to justify except experimentally or on excellent sites. Even then questions of the windfirmness of thinned stands would dictate a degree of caution.

Overstocking on past cutovers was not commonly observed. Where found, however, this condition can ordinarily be corrected economically on cutovers. Manual, mechanical and chemical methods are available. Successful use of bulldozers on dense immature pine stands of the foothills is documented.

Manual spacing would be costly, is feasible only on a small scale, and is most advantageously undertaken at a stage where surplus seedlings could be uprooted by hand. Chemical spraying on a significant scale would be suspect due to possible side effects on water quality.

The greatest increases in yield would result on excessively overstocked pine stands resulting from fire. Mechanical disturbance as a byproduct of pulpwood salvage could be effective locally, but methods like those described above are needed as a supplement and would be justifiable in terms of yield.

Well-timed efforts to correct overstocking can be important on the project area, but should seldom be given precedence over efforts to restock NSR lands.

3.4.5 Silvicultural Costs

Forest managers on the project area are committed to practices which will assure continued forest productivity. The cost of these practices will be highly variable, but currently is believed to average approximately as follows, on an acre basis:

1.	Scarification (including broadcast burning)			$18.00/acre
2.	Scarification and artificial seeding.	Scarification	$18.00	
		Seed (2 lbs/ acre at $10.00)	20.00	
		Application	5.00	
				$43.00/acre

3.	Scarification and planting	Scarification	$18.00	
		nursery stock	(free)	
		planting	25.00	
				$43.00/acr
4.	Juvenile spacing (bulldozing rows)			$12.00/acr

Applied to the economic model developed in the foregoing section, silvicultural expenditures might be distributed as in Table 3.18.

The example chosen is for a large-scale operation. Even allowing for increased unit cost at a smaller operating scales, it would appear that such an annual program is presently within the economic means of sawlog producers. If this were not so, these producers could still be assisted by reductions in stumpage payable to the Government. The same program on a purely pulpwood operation would require a sacrifice in profits below those defined as acceptable. Again, however, higher profits on sawlogs cut by the pulpwood companies, or stumpage concessions on those sawlogs, could be used in support of these silvicultural programs.

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TABLE 3.18

COST OF REPRESENTATIVE SILVICULTURAL PROGRAM

(Annual Cut 16,000 acres, 320,000 cunits)

Treatment	Application		Cost	
	Percent of Area	Acres	$M	$/Cunit Cut
1. No treatment required (advance regeneration, scarification done in skidding, etc.)	10	1,600	-	-
2. Scarification only	60	9,600	173	0.54
3. Scarification and artificial seeding	10	1,600	69	0.22
4. Scarification and planting	20	3,200	138	0.43
SUBTOTAL	100	16,000	380	1.19
Juvenile spacing	-	1,000	12	.04
BASIC PROGRAM			$392	$1.23

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CHAPTER III

PHOTOGRAPHS

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Photo 3.1 The AFS maintains extensive fire-detection coverage, including that provided by the Kakwa L.O.

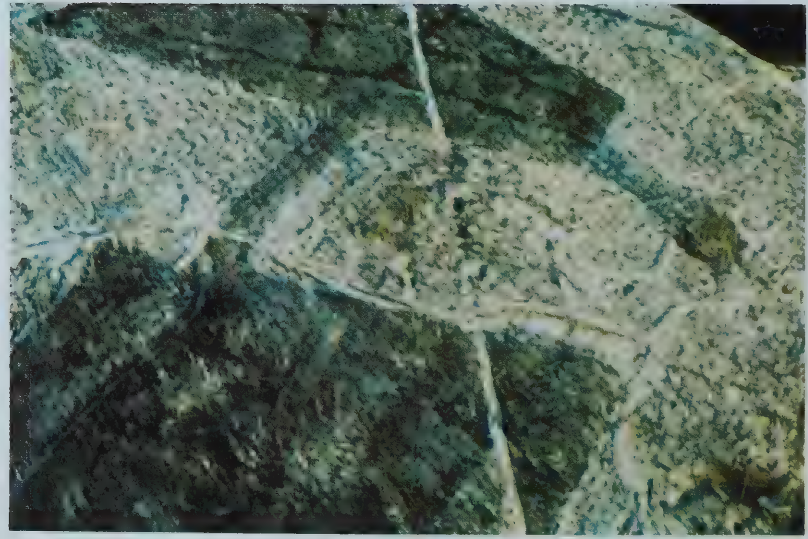

Photo 3.2 Darker patches were harvested over a decade ago, and have restocked with pine and poplar. Note concentration of pine on old roads. Game cover is good. Lighter patches were cut and scarified recently. NWPP Marlboro Working Circle.

Photo 3.3 This portion of the Procter & Gamble Trunk Road is well engineered and well revegetated by grasses and forbs.

Photo 3.4 Scrapers are used extensively by Procter & Gamble's main road construction contractor.

Photo 3.5   Borrow pit along Procter & Gamble main road is screened from view by aspen trees. These are probably not windfirm.

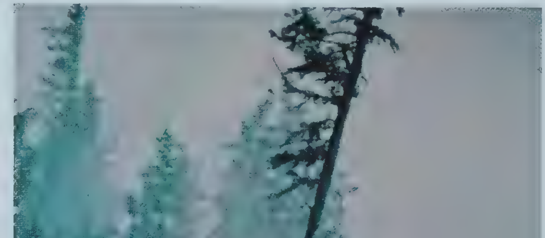

Photo 3.6   This Drott feller-buncher is used by NCFI in conjunction with grapple skidders. Steeper terrain or larger timber occasionally limit this machine.

Photo 3.7 Grapple skidders are effective on small timber and increase productivity per man. (NCFI operations near Musreau Lake).

Photo 3.8 Caterpillar Harvester, the basic woods machine of Procter & Gamble. This machine is expected to fell, limb, top and bunch 14,000 cords per operating year.

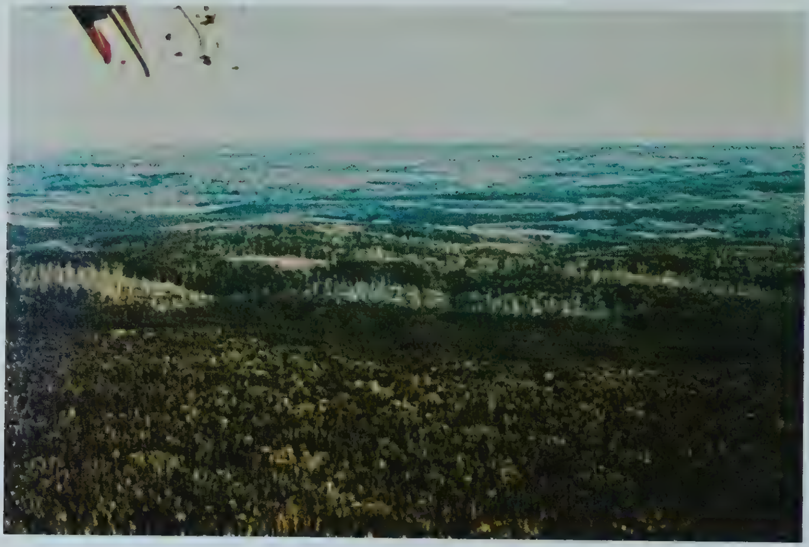

Photo 3.9 Cutting in this mixed spruce-aspen stand on the NCFI FMA has left well distributed unmerchantable poplars in checkerboard pattern.

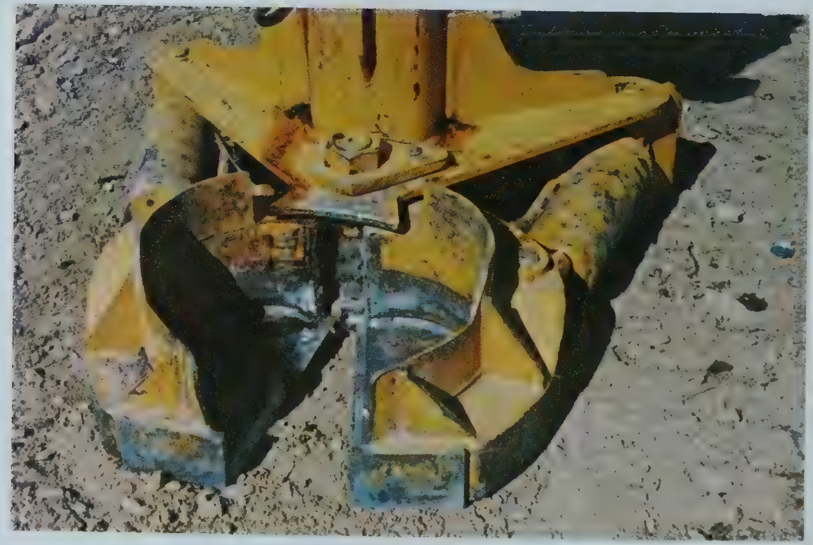

Photo 3.10 These Vulcan hydraulic tree shears, mounted on a shovel chassis, are in use on the Berland Working Circle, NWPP.

Photo 3.11 This white spruce natural seedling (May, 1973) exhibits normal development after two growing seasons. It will not be officially "established" until it completes one more growing season.

Photo 3.12 These pine cones on scarified cutover have opened and released approximately 1000 seeds per milacre here. (Marlboro Working Circle, NWPP)

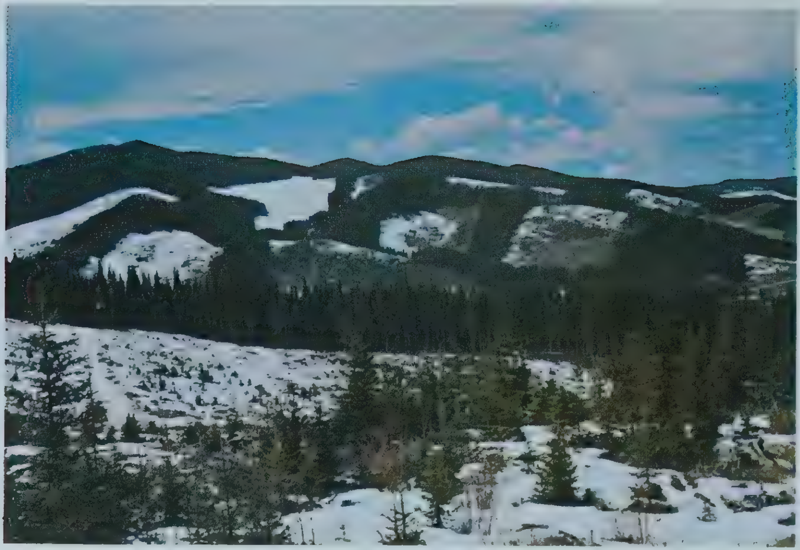

Photo 3.13 Foreground: McLeod Working Circle, Compartment II, NWPP. This area was harvested in 1964 and scarified in 1965. Understory fir and spruce is an important component of the new stand. Background: Warden Creek clearcut patterns are well designed and restocking satisfactorily.

Photo 3.14 Spencer-Lemaire pine seedling planted in the fall of 1971 on experimentally burned cutover in Athabasca XVI. (Photo May, 1973.) This seedling grew well in 1972.

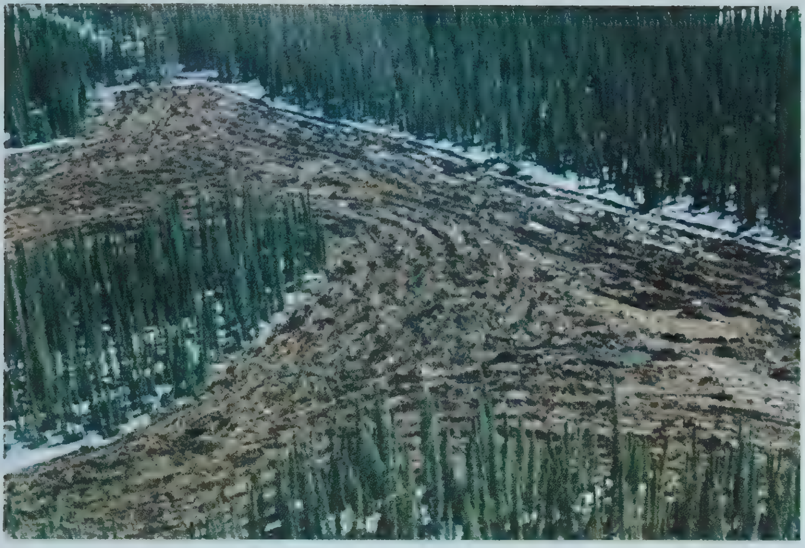

Photo 3.15 This "deep-duff" area in Athabasca XVI has recently been bladed for exposure of mineral soil.

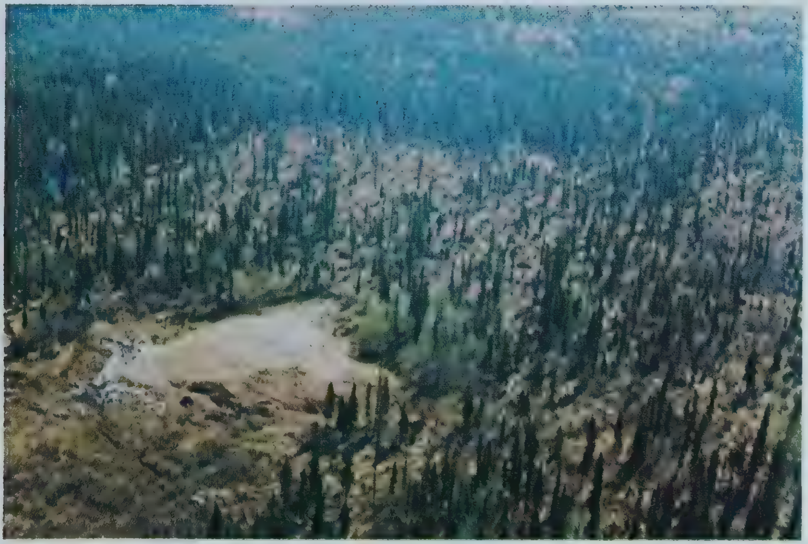

Photo 3.16 This mill site area in M.U. G7 was cut for sawlogs in 1961-63. Submerchantable spruces left act as a nurse crop and seed source.

Photo 3.17 NWPP crew planting Spencer-Lemaire pine stock with Potiputki planting tool. This "Camp 1" clearcut near Brule Lake is on Aeolian soil. It is an unstocked residual spruce strip cut in 1968.

Photo 3.18 Pine cones left on this high-site cutover will not release seed underneath dense cover. M.U. P2 (Peace River Forest).

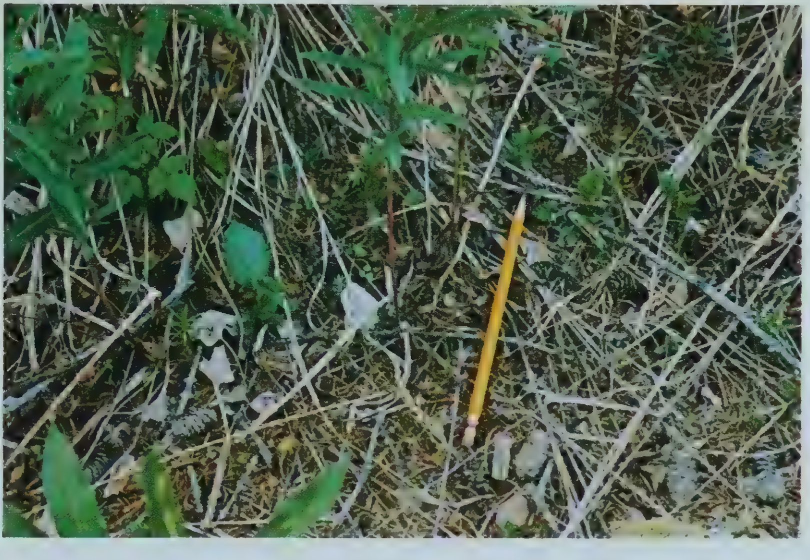

Photo 3.19 This scarified cutover was direct-seeded. White spruce regeneration is abundant, but may be attributable to natural seed sources in this case. (M.U. P2)

Photo 3.20 This spruce tree was planted in 1969, as 3-0, bare-rooted stock. Its 1971 and 1972 leader growth is encouraging. (Marsh Head Creek, M.U. W1)

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CHAPTER IV

4.0 ANALYSIS OF ENVIRONMENTAL IMPACT OF HARVESTING AND RELATED ACTIVITIES

Chapters II and III describe the environment and the phases of timber harvesting operations in some detail. Some of the major problems arising when these are brought together are described. A more systematic analysis of these problems is needed, and should include a rating of them in terms of gravity, probability, correctability, and persistence. This is a highly complex and subjective undertaking. It is best approached by preparation of an Environmental Impact Matrix (E.I. Matrix) following principles first introduced by the U.S. Geological Survey (Leopold, Clarke, Hanshaw, and Balsley, 1971).

4.1 Environmental Impact Matrix

Figure 4.10 is an Environmental Impact Matrix prepared with adaptations appropriate for this project. Major elements of the existing environment, taken from Chapter II, are listed vertically and lettered from A to Z. Major activities or events associated with forest harvesting and forest management are listed horizontally, numbered from 1 to 37. Just over 960 interactions are created by this 26 x 37 matrix, but only certain of these warrant analysis. Even this elimination process is subjective, but for example, the interaction of "winter trucking" on "fish" (Interaction R15) is considered insignificant in comparison with that of "grading and ditching" during road construction on "sensitive surface deposits" (Interaction A4). Interactions like R15 are left blank on the matrix.

Interactions which are considered potentially beneficial are colored green. For example, the interaction between "restocking, trees, prompt" and "surficial deposits, sensitive" (A35) is colored green. This classification is used sparingly for interactions where benefits are unmistakably realizable. The yellow and red denote increasing degrees of potential impairment, rated by relative universality, difficulty of correction or prevention, probability of damage, and duration of damage. Interaction A3 (roadside slash disposal on sensitive surficial deposits) is colored yellow; interaction A4 (grading and ditching on the same surficial deposits) is colored red since it is considered somewhat more important.

Certain series of interactions stand out in the matrix. Horizontally, the possibility of damage to sensitive surface conditions (Row A), intermittent streams (Row F), watershed values on steep terrain (Row G), fish (Row R), and aesthetic values (Row W) is suggested by the high frequency of red interactions. Vertically, the importance of prompt re-establishment of vegetation along roadsides and on clearcuts is emphasized by the high frequency of green interactions in columns 8 and 35. Conversely columns 4 (grading and ditching), 20 (ditches in service), and 27 (accidental fire) contain frequent red interactions, and column 36 (revegetation, non-tree, slow) emphasizes the far-reaching consequence of failure to re-establish forest or other cover quickly after crop removal.

Certain points of view underlying these ratings must be explained:

1. Harvesting activities will be governed by existing regulation and ground rules, at present levels of interpretation, AFS-industry cooperation, and technology. (The alternative assumption, that all written regulations will be observed and will have the desired effects, is considered somewhat premature.)

2. Threats to elements of the environment are identified and rated. These are potential, not inevitable. The exact nature of the threat under consideration is not shown on the Matrix, but should be clear from discussions which follow.

3. Certain elements of the environment vastly outweigh others in present-day economic importance (e.g., "Merchantable Timber Stands" vs "Birds"). Economic value in this analysis is given no greater weight than other recognized values. Economics may enter into the decisions to remove a threat, but not into its original identification. Measures which would counteract or remove identified threats are described in some detail in the following section. These are not necessarily firm recommendations, unless they reappear in Chapter V.

Details and explanations in the following sections are made with reference to the E.I. Matrix.

4.2 Vulnerable Elements of the Environment

1. Surficial Deposits (Row A, B, C)

   Four interactions (A8, A35, B8, B35) are marked in green, in recognition of the benefits of rapid revegetation on sensitive terrain. Ten interactions, on the other hand, are marked red in recognition of the threats to sensitive terrain from specified activities. Remaining interactions are yellow or blank, indicating medium threats, or no threat.

   Several activities which cut into sub-soils are part of the timber extraction process. These activities include road grading and ditching, material borrowing, stream crossing installations, skid road construction, use, and abandonment, and landing construction. All have important impacts on the steeper and more erodible surface deposits of the project area. Less sensitive or less steep deposits are affected to a lesser degree, but the complete absence of erosion and siltation hazards on these sites is rare even on insensitive surfaces. The potential for storm damage wherever excessive rainfall is flowing over raw earth has been described.

Table 4.1 summarizes, for several main roads on the project area, the incidence of road-caused erosion observed in June, 1973. These results emphasize that erosion problems are not theoretical, and that design and construction methods must be better on some roads than on others. In addition all observations provided convincing evidence that erosion becomes increasingly significant as one goes from lower to higher road standards.

Cutovers were inspected over the entire project area, with close scrutiny given to those on steep or sensitive terrain. Every instance of erosion was confined to roads, landings and the heavily used portions of skid roads. Eroded areas were in draws rather than on ridges. Tracked skidders are physically capable of operating on slopes where rubber-tired skidders are not. Two examples of tractor skidding on steep slopes (Terris, Hinton and the McIntyre Porcupine Contractor, Grande Cache) are relatively new, but exhibit potential for future erosion before revegetation can take place. Scarified areas that were visited were entirely free of erosion except in contact with roads and skid roads. These findings on clearcuts may appear at variance with the ratings shown on Rows A and B of the Matrix. The explanation is that cutting or scarification is still relatively rare on steep and sensitive areas within the project area.

Erosion on burns is uncommon except where productivity and operability were already marginal before burning. In general, it appears that undestroyed organic layers, debris, and undisturbed roots of fire-killed trees prevent erosion until revegetation takes place. The absence of soil disturbance by roads and skid roads appears to have provided a decisive advantage except on the most sensitive terrain (codes seven or eight, Table 2.2).

The environmental impact of these activities on sensitive or steep terrain could be reduced by:

TABLE 4.1

SUMMARY OF FREQUENCY OF EROSION ASSOCIATED WITH ROADS

Road Name	Minor Erosion	Major Erosion	Average Miles Between Erosion Problems
NCFI Smoky Road	12	5	3.8
Imperial Lbr. Road	8	8	1.7
NCFI - Musreau Road	7	2	2.3
NWPP Robb Road	7	1	6.0
NWPP Emerson Road	3	2	10.6
AFS Kakwa Road	20	1	3.5
AFS Trunk-road	6	0	12.0

Source:	Schulco field studies.
Minor Erosion:	Ditch erosion up to 3 feet deep, sheet erosion.
Major Erosion:	Washouts at streams, ditch erosion over 3 feet deep.

a) - Formal recognition of differences in sensitivity, and modification of design and construction practices on sensitive zonations. Roads in these zones could be narrower, less restrictive in grade and alignment (i.e., better fitted to contours) than elsewhere. Grubbing of stumps and removal of topsoil could be confined strictly to cuts, fills, and ditches. Ditches could be reduced in size as a result and could be further reduced by use of more frequent, smaller cross-drainage structures.

b) - Revegetation of cuts, fills, and ditches immediately after construction (i.e., 48 hours in some cases).

c) - Choice of insensitive areas for summer construction and harvesting (codes four or lower, Table 2.2).

d) - Prohibition of tractor skidding on sensitive areas. Introduction of uphill cable skidding in preference to downhill skidder operation on sensitive slopes.

e) - Use of log-decking and loading techniques which obviate construction of landings.

2. Soil Productivity (Row D)

One red interaction (D36) is noted, together with several yellow interactions.

There are possibilities for diminishment of soil productivity, short of outright removal of soil by erosion. This could occur by destruction of soil structure (for example, puddling or compaction of clayey soils by repeated machine travel during wet weather). Except at roadsides, few examples were seen, and none would be expected in winter or dry-weather operations. Revegetation would gradually correct such conditions, but might be difficult to establish. This possible threat is recognized in D36 of the Matrix. Measurable loss of chemical fertility for coniferous growth is not likely to result from harvesting. Soil productivity would diminish after repeated hot fires.

Recognized threats to soil productivity could be minimized by:

a) - Planned dispersion of skid road patterns.

b) - Planning of warm-weather operations on sandy soils.

3. Rivers and Streams (Rows E and F)

No red interactions are noted for main and secondary streams, but several yellow interactions are noted.

River banks and beds are usually affected only at infrequent major crossings. Proper control of construction at these crossings is essential for protection of rivers, and also for minimization of long-term costs. Past errors have caused damage and avoidable expense; recent installations appear generally more favorable in terms of protection, permanance, and ultimate cost.

Deposits of gravel for road surfacing are scarce in the Peace drainages. River gravel at crossings is at times the most obvious source within practical hauling distance. Examples of damage and continuing instability of riverbeds due to gravel borrowing were seen (e.g., Mumm Creek and Cutbank River).

Six red interactions are noted for intermittent streams. Road and harvesting developments are in intimate and frequent contact with smaller streams and intermittent streams. These streams are susceptible to bank erosion, sedimentation, oxygen depletion, temperature changes, and other environmental threats. Observance of the ground rules should reduce the frequency of damage, but probably will not prevent all damage, particularly in intermittent streams (see Row F of Matrix). Stream-bed and water quality could be protected by:

a) - Use of riverbed gravel for surfacing only after completion of a thorough search for alternate upland gravel or quarry sites proves the necessity.

b) - Essential river borrowing conducted only after inspection by a fisheries specialist, and according to approved planning and seasonal scheduling.

c) - Observance of ground rules in letter and in spirit.

d) - Detection of trouble spots in planning, rather than in execution. Many of the examples of streambank erosion observed could have been avoided by minor relocations, entailing no appreciable sacrifice in harvesting efficiency.

e) - Extra supervision at road-stream crossings.

f) - Avoidance of summer skidding along intermittent streams or draws (examples of winter skidding were apparently not harmful in smaller draws).

g) - Selective removal of dominant trees, particularly spruce, from streamside protective belts, to reduce subsequent windfall.

4. Watershed Values (Rows G, H, and I)

Ten red interactions are noted under Watershed Values. Together with those already noted under "Surficial Deposits" and "Rivers and Streams", which are intimately connected, these indicate considerable potential for damage. As indicated already, the potential for watershed damage depends on the characteristics of the watershed and the care exercised in planning and operations. Water quality, temperature, and seasonal flows can unquestionably be adversely affected by road drainage systems, heavy cutting, or delayed restocking. Row G, referring to upper slopes, indicates the major threats which must be recognized. Lesser threats are reflected by entries in Row H and Row I. Field studies of main roads indicated greatly varying standards and drainage effectiveness of bridges and culverts. Table 4.2 indicates a lack of drainage associated with several main roads. Secondary roads inspected have similar shortcomings in many cases.

Adverse impacts on watersheds could be reduced by:

a) - Observance of measures already outlined above (1 and 3).

b) - Identification of sensitive watersheds (see Table 2.4 and Watershed Classification Overlay, Volume 2).

c) - Identification of sensitive portions of watersheds (see Soil Stability and Slope Overlays, Volume 2).

d) - Relaxation of road width, grade, alignment, and right-of-way standards where watershed protection requires emphasis.

TABLE 4.2

SUMMARY OF FREQUENCY OF DRAINAGE STRUCTURES

Road Name	Average Drainage Structures Per Mile	Remarks
PG Roads	N/A	Good
NCFI Smoky Road	2.2	Inadequate frequency
Imperial Lbr. Road	1.1	Very poorly drained
NCFI Musreau Road	1.6	Inadequate frequency
NWPP Emerson Road	3.0	Good
NWPP Robb Road	1.7	Good
AFS Kakwa Road	2.1	Some areas inadequate
AFS Trunk-road	1.7	Good
Grande Cache & Luscar Hwys.	N/A	Good

Source: Schulco Field Studies.

Note: Frequency of drainage structure required is dependent on a number of factors, but the figures shown can be used as a rough guideline of quality of drainage.

e) - Correct installation of culverts, in sufficient numbers to handle storm rainfall and spring runoff.

f) - Restrictions on siting of "gully blocks", and on depth of earth fill where used.

g) - Retention of vegetative filters between ditches and streams.

h) - Fire prevention and suppression to limit burned acreages within any watershed.

i) - Identification of watersheds containing "solid mature" stands for intensification of measures such as rapid restocking, winter cutting, delayed second cuts, and increased strip cutting. These measures would not be so important where mature timber makes up a low percentage of watershed area, or where terrain is insensitive to erosion.

j) - Use of strip cutting systems along contours for pine and spruce types as stipulated by new ground rules.

5. Lakes (Row J)

Lakes are not frequent throughout the area, and not all are of fishing or recreation quality. Those surrounded by cutover lands (e.g., Wildhorse and Kinky Lakes) reflect the aesthetic soundness of the new cutting treatments agreed to under new ground rules. Old cutting operations left these lakes with aesthetically inadequate and unimaginative timbered margins, at least until restocking attains reasonable height.

On operations close to small lakes, which are more sensitive to local disturbance than large lakes, unbuffered ditches and warm-weather skidding may cause persistent turbidity (J20, red).

6. Merchantable Timber Stands (Row K)

Just as merchantable stands are the main focus of harvesting operations, their treatment is of extreme importance. As the forests go, so goes almost every other element of the forest environment of the project area.

Direct disruption of forest cover by road construction is localized, but the effects of road use may be to introduce a new potential for man-caused fire. Apart from this effect, the road-associated activities cause strikingly less threat to merchantable timber stands than to any other major element of the environment.

Forest management activities are designed to grow timber of the type needed in industry, but this means also maintenance of all forest cover. Accidental fire, epidemics, and delayed or non-tree restocking are ranked as serious potential threats to merchantable timber stands. Their occurrence is in the interest of no one and will be prevented wherever possible. Replacement of commercial stands with brush or unmerchantable species was once a threat when recurring fires swept the project area, sometimes preventing development of cone-bearing conifers over large areas, but ordinarily fires appear to have threatened soil, watershed, and other values to a lesser degree than roads and harvesting. Persistent forest management will favor the gradual reintroduction of conifers into presently deciduous stands of the area. Efforts to restock conifers will undoubtedly benefit the growth and development of forests generally, both technically and environmentally, as indicated by K35 in the E.I. Matrix.

The use of chemicals as fertilizers or for control of insect epidemics, brush competition, or rodents, has been negligible on the project area to date. These chemicals could threaten many other environmental elements, but obviously would favor coniferous forests (K39). Future chemical applications of an order likely to damage any component of the environment will probably be avoided.

7. Unmerchantable or Non-tree Cover (Row L)

The importance of this type of cover is indicated above. No direct threats are visualized. Harvesting operations will bypass these areas except where road development through them is occasionally necessary. Immature, low-site, and deciduous stands are therefore secure from direct harvesting and usually will be relatively secure from fire damage. Indeed they provide needed neutral buffers between areas which are planned for cutting, and thus will be an important factor preventing damage to the other biotic elements when merchantable stands are locally and temporarily depleted.

8. Sensitive Plant Communities (Row M)

These communities are as follows:

- swamp and muskeg: Sensitive to minor disruption by road drainage systems;

- alpine meadows: Sensitive to road construction (e.g., during coal exploration) and to repeated burning.

Neither of these types of community is likely to be encroached upon by harvesting operations which are directed at merchantable timber.

9. Decomposers (Row N)

No harvesting activity or event seriously threatens the effectiveness of decomposing organisms in the soil or water. Removal of overmature timber stimulates decomposition of forest litter accumulated for centuries, with effects beneficial to regeneration and growth of new stands. New rules providing for the removal of harvesting debris from streams will prevent the over-taxing of decomposing organisms in these waters.

10. Scarce Plant Communities (Row O)

No scarce plant communities were identified within forest lands under management. Riparian and aquatic communities will be protected from destruction by cutting practices. Alpine communities will be bypassed in forest road development.

11. Large Mammals (Row P)

The big game populations of the project area face some threat from harvesting operations, but also will reap some benefits. The extent to which habitat type supports the different big game species is summarized in Table 4.3. From this it can be seen that the large ungulates (deer, moose, and elk) will thrive on cutover or burned lands after a suitable period for revegetation, and provided some mixed woods, riparian or bog areas, and grass lands are also available. The habitat preferences of black bear are generally similar. Those of sheep and goat involve lands close to or above timberline, with winter requirements for timber shelter as noted below. Mountain caribou and grizzly bear are the species which receive little or no benefit from recent cutovers or burns, and on the contrary require mature coniferous or mixedwood forests as an important part of their full range of habitat.

Field investigations conducted in the spring of 1973 led to more detailed findings as follows:

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TABLE 4.3

RELATIONSHIPS BETWEEN BIG GAME AND PLANT COMMUNITY TYPES AS HABITAT

ANIMAL	PLANT COMMUNITY TYPE							
	RECENTLY BURNED	RECENTLY LOGGED	DECIDUOUS GROWTH	MIXEDWOOD GROWTH	PINE FOREST	SPRUCE FOREST	RIPARIAN AREAS AND BOGS	ALPINE GRASS-LAND
Deer	E	E	GW	E	F	F	GW	GSp
Elk	G	G	FW	FW	F	F	GW	E
Moose	G	G	E	G	P	P	E	P
Sheep	-	-	-	-	-	-	-	E
Goat	-	-	-	-	-	-	-	E
Caribou	P	P	FW	FW	G	G	GW	G
Black Bear	G	G	F	E	G	G	G	P
Grizzly Bear	P	P	P	G	G	G	P	G

(E = excellent; G = good; F = fair; P = poor; Sp = spring; W = winter)

a) Deer, elk and moose:

- evidence of browsing and fecal pellets indicating a consistent pattern of winter browsing in cutovers, on mainly willow, dogwood, and alder, and concentrated near timber edges (see Table 3.17);

- extensive use of the marginal uncut timber for shelter (indicated by pellet counts which tended to diminish with distance from timber edge);

- more winter dependence upon river valleys and deciduous types in the Grande Prairie forest than in the Edson forest, and hence less utilization of heavily cut areas in the Grande Prairie forest;

- evidence that judicious cutting in "solid" mature coniferous areas creates new winter feeding range in the headwaters of the northern rivers (for example, the upper Kakwa).

These three ungulates appear able to tolerate moderate contact with roads, campsites, hunters, and other activities anticipated. Their winter use of an individual operating area will progressively increase from the second to the tenth year of a 20-year cutting cycle; then diminish until the twentieth year, when available uncut mature timber is removed. The presence of uncut submerchantable coniferous stands, deciduous stands, and other cover in and surrounding the operating area will reduce this impact of cutting substantially. Under wildlife management, the compatibility of deer, moose and elk populations with forest management throughout the project area seems assured.

b) Mountain sheep and goat:

Tree cover for sheltering these ungulates during severe winter conditions is required close to known wintering areas. Provision of a local buffer strip approximately one mile in width, usually consisting of low-site timber, would entirely satisfy this need.

c) Mountain caribou:

This species depends in winter upon tree lichens found only on mature spruce and fir. Total management of the project area on an 80-year rotation would gradually (over about one rotation) force the withdrawal of caribou into the Willmore Park area from present range. To the extent that sawlog rotations are longer, and that Crown lands in the center of the project area are presently uncommitted, this withdrawal may be even more gradual. Enlargement of Kakwa Falls park would convert this area to permanent and highly suitable caribou range. A second area centering on Pierre Grey Lakes consists of black spruce of low operability, and might be reserved as caribou range without sacrifice of major timber values. The shyness and vulnerability to hunting of this species would add to the desirability of retaining areas free from development or hunting activity. Major sacrifices of productive forest land for this purpose probably are not justifiable, since suitable lowland and upland caribou range is available in Willmore Park.

d) Bear:

No diminishment of black bear habitat or populations due to timber harvesting is anticipated. The grizzly bear is a different case. The combination of shyness to human encroachment and preference for timber habitat probably means gradual withdrawal into park lands to the west.

e) Cougar:

Cougar populations elsewhere have increased with deer populations as cutting has extended. This would be expected on the project area, unless hunting pressure on cougar counter-balances this trend.

f) Managed Species:

Apart from the mountain caribou and grizzly bear, which may ultimately be confined to non-productive forest lands or Parks west of the project area, other large mammals represent excellent opportunities for permanent game management on the project area.

Road construction and use as anticipated (P1 to P26 in the E.I. Matrix) are considered generally innocuous to large mammal populations. Revegetation of road embankments and landings is shown as a positive (green) influence, although not of major consequence. The use of old roads by game is heavy, but is obviously not essential. Road surveys, clearing, and construction are of short duration and on confined areas. Their effects are shown as yellow (medium threat) or blank (no appreciable effect). Road use and maintenance activities are recurring. Several of these are marked yellow, with generally low probability and medium preventability, assuming that the exact nature of the threat can be determined promptly. Camps, snow plowing, winter trucking, road surfacing chemicals, road reconstruction, and garbage are shown as yellow. The threat of hunter and all-terrain vehicles is also noted in connection with roads, on the premise that infractions of existing game regulations are presently difficult to prevent.

Threats to large mammals from forest management and harvesting activities are difficult to analyse quantitatively, but are considered greater than those from road activities. The threats of accidental (large) fires, patch clearcutting (250 to 500 acres) and slow restocking, are considered real and cumulative, where important big game range is affected. These three interactions (P27, P29, and P36) are marked red.

The threat of a large fire is less than in the past, but could still destroy habitat on a large scale and for several years.

The potential threats of patch cutting and slow restocking are to limit usable combinations of feeding and shelter cover, as explained in Chapter III. Feeding at the center of a large cutover has been shown to be light in comparison with feeding near timber edges. It is difficult to define the critical acreage at which stimulated growth of browse species is nullified by distance to shelter, but a 160-acre block might be of an order to permit adequate combinations of browse and shelter (animals never more than approximately 20 chains from a shelter type). Strip cutting, though clearly superior to patch cutting during the first-cut, is no better during the second cut unless first-cut strips restock promptly enough to replace the shelter being removed.

The type of shelter afforded at the critical stage in the cutting cycle (expressed as mean height of the new crop on first-cut blocks when all second-cut timber is removed) is probably more critical than browse supply. Except where alternate shelter in undisturbed deciduous or unmerchantable stands is available, first-cut blocks must provide this shelter. Wildlife biologists have stated that these new crops will begin to provide adequate game cover when dominant trees average 15 feet in height. The "6 to 8-foot, 20-year Rule" is a compromise between this criterion and the desire to adhere to a ten-year interval between commencement of first and second cuts on a given operation. This rule is helpful in reducing the extent and shortening the period of habitat disruption, but still requires that game populations migrate in search of adequate food and shelter combinations.

Conifer restocking on cutovers is seldom so dense as to exclude adequate forage vegetation. Prompt coniferous restocking is thus disregarded as any threat to game.

Measures which would soften harmful effects of harvesting operations on big game are:

- comprehensive and detailed mapping of game habitat, populations, and movements

- review of timber development plans by wildlife biologists for early identification of local problem areas

- designation of a reasonable proportion of forest lands as critical game management zones, subject to special treatment. This special treatment would be accompanied by relaxation of treatment elsewhere. A tentative proposal in this direction is given in R16 (Chapter V)

- determination of realistic game harvest levels under improved game management, with corresponding hunting seasons and bag limits to be enforced.

12. Small Mammals (Row Q)

The three small mammals likely to be adversely affected by local heavy cutting are the squirrel, which relies on mature conifer seed and habitat, and the marten and fisher, which prey upon squirrels to a considerable degree. With large populations and ample opportunity to migrate from stand to stand, serious or permanent adverse effects are unlikely.

All other native small mammals are expected to adapt to or thrive under forest management practices. Trapping is a threat to some furbearers locally, but not a major threat to small mammals generally.

13. Fish (Row R)

Lake fish populations appear secure against damage from planned harvesting operations, other than the possibility of increased turbidity through road drainage. Some stream waters, particularly in the north, are of lower quality than others, but the project area in general has sport fishing values worthy of reasonable protection. In one important respect this protection is not being received at present, due to apparent lack of concern in culvert installations. Table 4.4 illustrates the degree to which suitable fish streams are presently blocked by road crossings. Culverts, not bridges, are the offending structures in all cases. Of 105 crossings observed on these streams, 40 were unmistakably blocked to fish passage. In all 40 cases the barriers were caused by excessive vertical drop of stream waters at the culvert outlet. Where these barriers are located to interfere with spawning migrations to upstream gravel beds, substantial reduction of migrating populations has already occurred.

Increased water temperatures resulting from removal of tree cover are a potential threat to fish in streams. It is probable, however, that the shading and buffering provided along secondary water courses, coupled with the cut-leave block system, will produce only minute changes in temperature.

Stream turbidity is critical during the egg and alevin stages in several fish species, and also inhibits the occupation of certain streams by adults of several species. In general, it appears that increased turbidity during spring freshets (when turbidity is a normal condition) is less serious than unnatural occurrences in late summer or fall. New roads are a potential

TABLE 4.4

SUMMARY OF POSSIBLE FISH STREAMS BLOCKED

Road Name	Total Possible Fish Streams Crossed	Total Blocked	Percent Blocked
PG Roads	12	2	17
NCFI Smoky Road	17	8	47
Imperial Lbr. Roads	6	4	67
NCFI Musreau Road	5	0	0
NWPP Emerson Road	15	7	47
NWPP Robb Road	8	1	12
AFS Kakwa Road	11	4	36
AFS Trunk-road	4	1	25
Grande Cache & Luscar Hwys.	27	13	48
TOTAL	105	40	38

Source	Schulco field studies.

Figures shown include bridges and culverts on streams and rivers which are known to have fish populations or which are highly likely to have fish populations.

source of excessive, unseasonal turbidity and sedimentation. Indications of this are given in Table 4.5, which shows turbidity readings upstream and downstream from crossing points, as recorded during a rainstorm in June, 1973.

The new ground rules which prohibit deposition of debris in stream beds will be of importance in preventing degradation of fish habitat in slow moving streams.

Excessive fluctuations in water levels of small streams might result from heavy local cutting, but should be prevented under proposed management practices.

Fish habitats could be preserved and improved by:

- care in future culvert installations and a program for reconstruction or re-installation of existing culverts which block identifiable fish streams.

- observance of measures for erosion control and watershed protection specified in ground rules and discussed above.

Effective measures to prevent over-fishing or to replace depleted waters by fish stocking (generally a less desirable alternative) are needed in addition to the above measures for protection of habitat. The effect of fishermen on fish (R23) is shown as yellow because current regulation of fishing appears inadequate to meet future needs with extended access and sport-fishing pressures at favored spots.

14. Birdlife (Row S)

Apart from destruction of individual nesting sites, which are normally not common in any event in dense coniferous stands, the timber harvesting operations will have no apparent impact on bird populations. Upland game birds

TABLE 4.5

TURBIDITY MEASUREMENTS* ABOVE AND BELOW STREAM CROSSINGS ON THE GRANDE CACHE HIGHWAY DURING A RAINSTORM; JUNE 25, 1973

SITE NO.	STREAM	TRIB. TO	DIST. ABOVE ROAD (YDS)	READING (F.T.U.'s)	DIST. BELOW ROAD (YDS)	READING (F.T.U.'s)
53	Unnamed	Lone Teepee Creek (Muskeg River)	150	90	200	1,440
54	Shand Creek	Lone Teepee Creek (Muskeg River)	100	45	100	2,000
55	Hendrickson Creek	Berland River	100	32	100	35
61	Hightower Creek	Wildhay River	100	40	100	58
62	Fred Creek	Pinto Creek	100	37	100	124

*Turbidity measurements taken with HACH DREL-2 Portable Spectrophotometer.

thrive on a mixture of cutovers and heavier cover. Waterfowl are not widely distributed, but their aquatic habitat will be unaffected by upland logging and road activity. No direct threat other than that of massive chemical spraying can be visualized. As with most other elements of the biotic environment, the prevention of large fires and their replacement with a mosaic of different cover types will benefit birdlife.

15. Insects (Row T)

No significant interactions except for the possible use of chemical pesticides.

16. Special Interest and Threatened Species (Row U, V)

Mountain caribou, grizzly bear, and cougar are of special interest because of their forced retreat before human encroachment in North America. Possible measures for their protection have been outlined above. The buffalo provides a historical precedent which few wish to see repeated. Birds of prey, particularly the falcon, breed slowly and are vulnerable to hunting, insecticides and disruption of nesting sites by cutting. Appropriate hunting restrictions exist, but action to identify nesting sites for reservation from immediate cutting may be lacking.

17. Aesthetic Values (Row W)

The natural environment is clearly made more generally accessible by roads and cutting. However, these activities temporarily degrade its aesthetic value.

Roadside foregrounds can be improved by good clean-up practices, screened borrow pits, and narrower right-of-way clearings. The damage to more distant views can be alleviated by partial cutting, smaller clear-cut areas, prevention of wildfires, avoiding special areas, and using irregular cutting boundaries.

18. Archaeological and Historical Values (Row X, Y)

Archaeological and historical values could be damaged by human intrusion and disregard. These values can be protected by education of forest workers, careful location of campsites and by identification and protection of specific sites. Many of the prehistoric sites are confined to belts along the rivers, from 100 to 200 feet above present riverbeds. The attention of specialists when these zones are traversed in road construction would be useful.

19. Recreational Values (Row Z)

Recreational values are in some cases improved and in other cases degraded by extensive forestry activities.

Steps to reduce the damage are as follows:

- provision of more campsite facilities so as to prevent uncontrolled camping along forest roads, or overcrowding of established sites;
- deliberate destruction or closing of unused roads so as to prevent unwanted vehicle access;
- use of higher road standards where appropriate so as to facilitate safer public use of roads for recreation;
- prevention of wildfire;
- improvement of aesthetic values as previously outlined;
- deletion of areas from forest harvesting which have a higher value for recreation than timber production;

- special forest management standards and techniques in areas which have a high potential use for recreation.

4.3 Geographic Distribution of Environmental Conflicts

Inspection of Volume 2 will reveal extensive local compounding of environmental elements potentially threatened. Potentials for damage to environmental values are not uniformly distributed, but rather are concentrated in recognizable zones. For example, certain lowland areas present little reason to restrict full-scale timber harvesting. Concurrently other zones, commonly on upper slopes or in river valleys, require whole series of land-use decisions for or against modification of cutting to protect fish or game habitats, recreation or scenic values, and watershed values. In a few cases, almost every environmental element from A to Z in the E.I. Matrix, to say nothing of others which may yet be identified, are represented on the same area, and require consideration. It is obvious that decisions which assign land-use priorities are needed in these cases, and that special measures to avoid unnecessary damage to secondary values will be desirable. Detailed mapping is one basic tool needed on much of the project area to enable these localized decisions.

4.4 Summary

From the E.I. Matrix analysis it is clear that roads and their by-products are presently causing much more widespread disturbance of the project area than harvesting *per se* or silvicultural practices. Roads have two effects on environmental values. First, road construction and operation impose physical changes which have been described. Second, roads are the means of human occupation for settlement, industrial activity, or recreation. Clearly the harmful effects of roads can be minimized if the road density can be minimized, and if roads can be located and designed to satisfy multiple purposes without duplications. Even after good planning, many details of construction, maintenance, and uses, specific to the site, are critical determinants of environmental impact.

The phases of harvesting have effects similar to roads, but to a lesser degree, provided harvesting is regulated as anticipated. It is evident, however, that some localized modification of cutting patterns and schedules is desirable to prevent gradual deterioration of big game habitat.

Whereas roads and harvesting constitute threats to the environment which can be minimized, silvicultural treatments constitute benefits to the environment which can be maximized. Only failures of these treatments will threaten the environment seriously. The contrast between columns 35 and 36 of the Matrix illustrates this.

Sustained Yield Forest Management is not the only conceivable option open for the project area, but it has been considered the best. Table 4.6 provides a crude comparison between:

- forest management to the established standards;

- total exclusion of all industry and development;

- unrestricted cutting for maximum short-term profits.

Plus signs in Table 4.6 indicate general compatibility with the natural environment; minus signs, noncompatibility; zeros, some mid-way value between these extremes.

Combined totals for each of the three options are:

TABLE 4.6
EXAMINATION OF BASIC LAND USE OPTIONS

	EXTREMES		MANAGE BY ESTABLISHED STANDARDS			
CRITICAL ENVIRONMENTAL ELEMENTS	Exclude all Industry and New Roads	Max. Immediate Profit to Forest Industry	Road Development and Occupation	Harvesting	Post-Harvesting Treatment	Total Impact
PHYSICAL:						
Soils	-/+	-/-	0/-	0/+	0/-	
Waters	-/+	-/-	0/-	0/+	0/0	
FLORA:						
Coniferous Forest	-/+	-/-	0/0	+/+	+/+	
Deciduous Forest	0/+	+/+	0/0	0/0	0/0	
Herbaceous Cover	0/0	+/+	0/0	0/0	-/-	
Aquatic	0/0	0/0	-/-	0/0	0/0	
FAUNA:						
Big Game	0/0	-/-	-/-	0/0	0/-	
Small Game	0/0	-/-	0/0	0/0	0/-	
Birds	0/0	-/-	0/0	0/0	0/0	
Aquatic	0/0	-/-	-/-	0/0	0/0	
HUMAN:						
Industry, Employment	-/-	-/-	+/+	+/+	+/+	
Recreational, Aesthetic	-/0	-/-	0/0	0/0	0/0	
Local Economy	-/-	-/-	+/+	+/+	+/+	
COLUMN TOTAL	-6/+2	-8/-8	-1/-3	+3/+5	+2/-1	+4/+1
NET TOTAL	-4	-16	-4	+8	+1	+5

Codes:

Code 1: Universality, Ease of Control, Gravity

+	Limited extent or easy to control or slight damage
0	Mid-value
-	Widespread effects or difficult to control or heavy local damage.

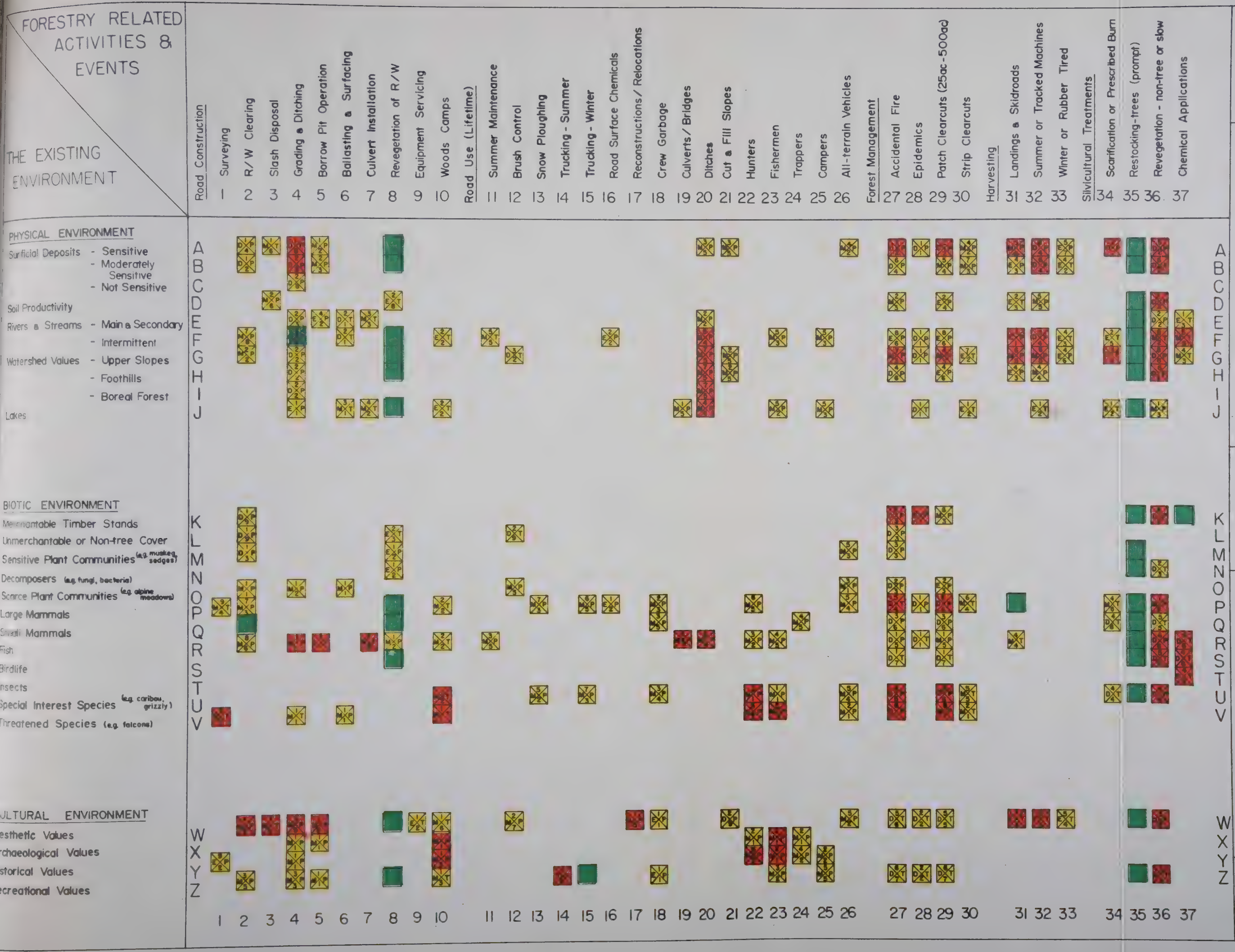
Code 2: Probability and Permanence of Damage

+	Improbable or temporary
0	Mid-value
-	Probable permanent damage

- forest management to established standards	+ 5
- total exclusion of industry and development	- 4
- unrestricted short-term development	-16

It would be unwarranted to use this comparison in any quantitative sense, but the forest management option presently in effect appears on balance to be conspicuously superior in pure environmental terms to the other two options. There probably is no longer a choice between these options, but it would be difficult to prove that the present basic land-use decision is wrong for the area. The important new challenge lies in the formulation of optimum land-use plans and in their orderly execution.

FIGURE 4.10
ENVIRONMENTAL MATRIX OF EFFECTS OF TIMBER HARVESTING OPERATIONS IN THE EDSON & GRANDE PRAIRIE FORESTS OF ALBERTA


FORESTRY RELATED ACTIVITIES & EVENTS
THE EXISTING ENVIRONMENT
Road Construction
1 Surveying
2 R/W Clearing
3 Slash Disposal
4 Grading & Ditching
5 Borrow Pit Operation
6 Ballasting & Surfacing
7 Culvert Installation
8 Revegetation of R/W
9 Equipment Servicing
10 Woods Camps
Road Use (Lifetime)
11 Summer Maintenance
12 Brush Control
13 Snow Ploughing
14 Trucking - Summer
15 Trucking - Winter
16 Road Surface Chemicals
17 Reconstructions / Relocations
18 Crew Garbage
19 Culverts / Bridges
20 Ditches
21 Cut & Fill Slopes
22 Hunters
23 Fishermen
24 Trappers
25 Campers
26 All-terrain Vehicles
Forest Management
27 Accidental Fire
28 Epidemics
29 Patch Clearcuts (25ac-500ac)
30 Strip Clearcuts
Harvesting
31 Landings & Skidroads
32 Summer or Tracked Machines
33 Winter or Rubber Tired
Silvicultural Treatments
34 Scarification or Prescribed Burn
35 Restocking-trees (prompt)
36 Revegetation - non-tree or slow
37 Chemical Applications
PHYSICAL ENVIRONMENT
Surficial Deposits - Sensitive A
- Moderately Sensitive B
- Not Sensitive C
Soil Productivity D
Rivers & Streams - Main & Secondary E
- Intermittent F
Watershed Values - Upper Slopes G
- Foothills H
- Boreal Forest I
Lakes J
BIOTIC ENVIRONMENT
Merchantable Timber Stands K
Unmerchantable or Non-tree Cover L
Sensitive Plant Communities (e.g. muskeg, sedges) M
Decomposers (e.g. fungi, bacteria) N
Scarce Plant Communities (e.g. alpine meadows) O
Large Mammals P
Small Mammals Q
Fish R
Birdlife S
nsects T
Special Interest Species (e.g. caribou, grizzly) U
Threatened Species (e.g. falcons) V
ULTURAL ENVIRONMENT
esthetic Values W
rchaeological Values X
istorical Values Y
ecreational Values Z

Legend:

A. Importance of Interaction (colour code)

- 🟩 Potential Benefits
- 🟨 Medium Threat
- 🟥 Major Threat

B. Basis of Importance Rating

1. Universality (local vs regional) small (1) to (10) large
2. Temporary (T) or Permanent (P-5yrs+)
3. Probability of Damage low (1) to (10) high
4. Correctability / Preventability

Easy	E
Medium	M
Difficult	D

EXAMPLE OF IMPACT RATING ANALYSIS

Magnitude
Correctability/ Preventability → E 1 T 10 ← Temporary
Probability

EXPLANATION

1. Select a horizontal row for inspection. e.g. What activities related to forest use have an effect on threatened species ? On large mammals ?
2. First look at red squares, later yellow then green.
3. Secondly study numbers in box to interpret impact significance.
4. Inspect vertical columns for activities or events which appear to affect several environmental elements at once. Modification of these would most effectively reduce environmental impact.

For: Alberta Government

C.D. SCHULTZ & COMPANY LIMITED
VANCOUVER CANADA

Date: September 1973

CHAPTER IV

PHOTOGRAPHS

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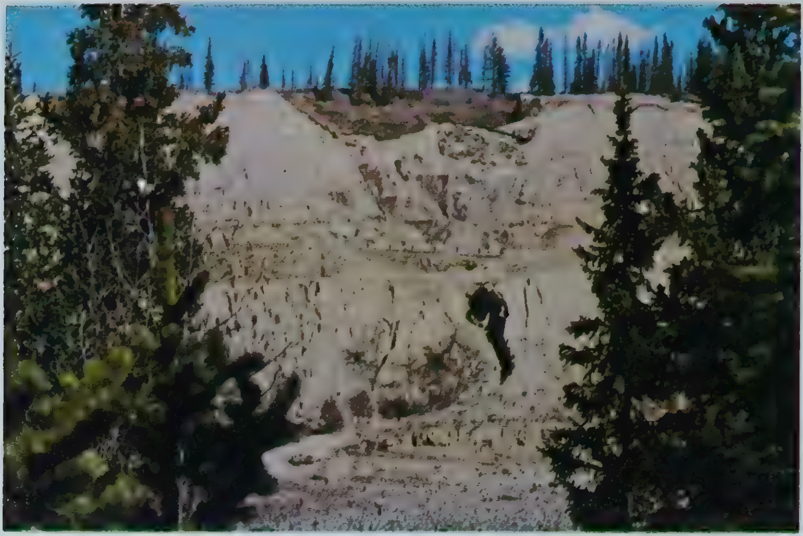

Photo 4.1 This cut along the Grande Cache Highway is exhibiting extensive sheet and gully erosion, depositing sediments into the Athabasca River. Timber extraction roads produce less spectacular damage normally, but minor erosion is more widespread.

Photo 4.2 Unbuffered ditch sediments run directly into this creek along the Luscar Road.

Photo 4.3 Unstripped roadside soil is likely to stabilize rapidly. (Department of Highways construction near McNeil Creek, Hinton)

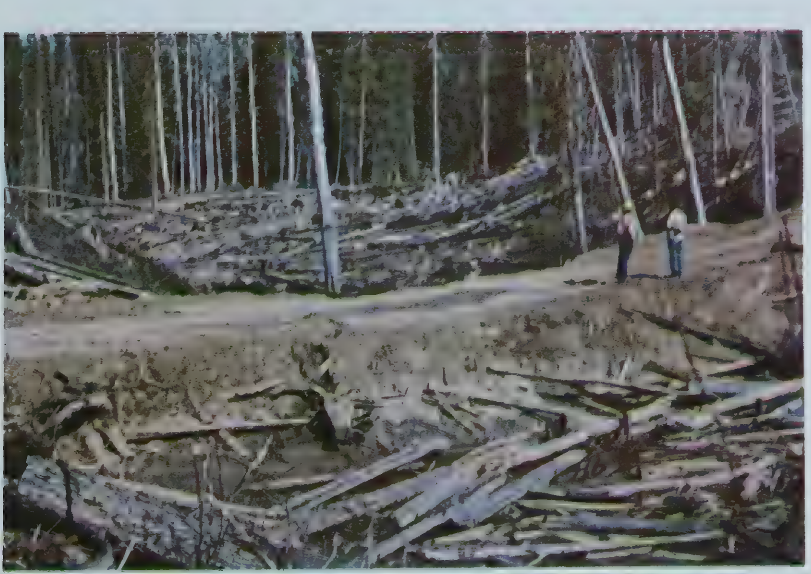

Photo 4.4 This "gully-block" is on a Class III road of NCFI.

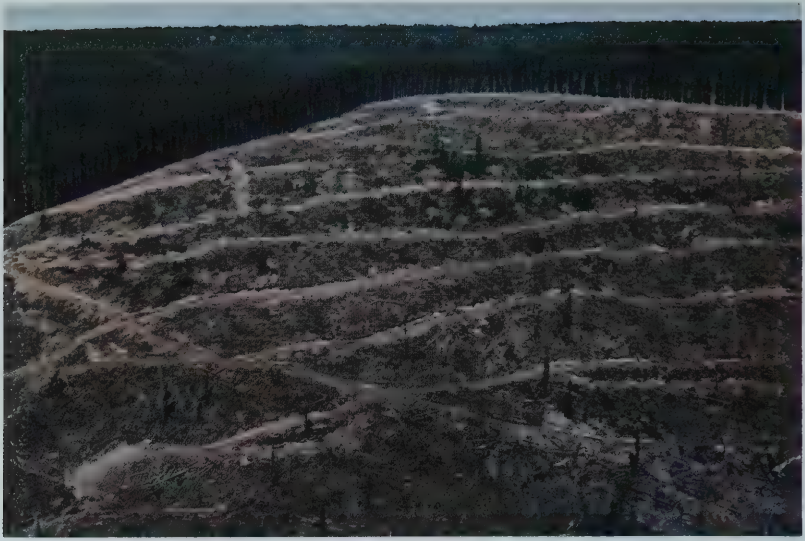

Photo 4.5 Steep slope recently tractor-skidded may erode. (Simonette River sawlog operation)

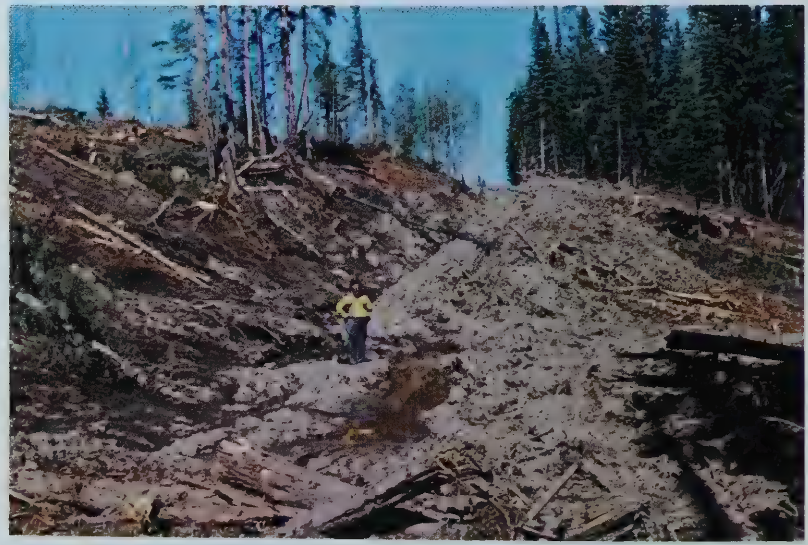

Photo 4.6 Spring skidding and hauling was costly and created erosion potential. (Procter & Gamble's 1973 cut)

Photo 4.7 This NCFI skidroad was almost undisturbed by January 1973 skidding.

Photo 4.8 Foreground: Excellent pine restocking of area cut in 1960. Midground: Recently cut and scarified residual block. Background: More restocked 1960 cutover and uncut timber.

Photo 4.9 Buffer zone around lake preserves recreational potential, wildlife habitat and visual quality.

Photo 4.10 The protection of river banks is important to control erosion and to preserve recreation potential, wildlife habitat and visual quality.

Photo 4.11 Sensitive high elevation areas are not disturbed by forestry activities, which are confined to merchantable timber stands.

Photo 4.12 A pleasing landscape showing diversity of landform and vegetation.

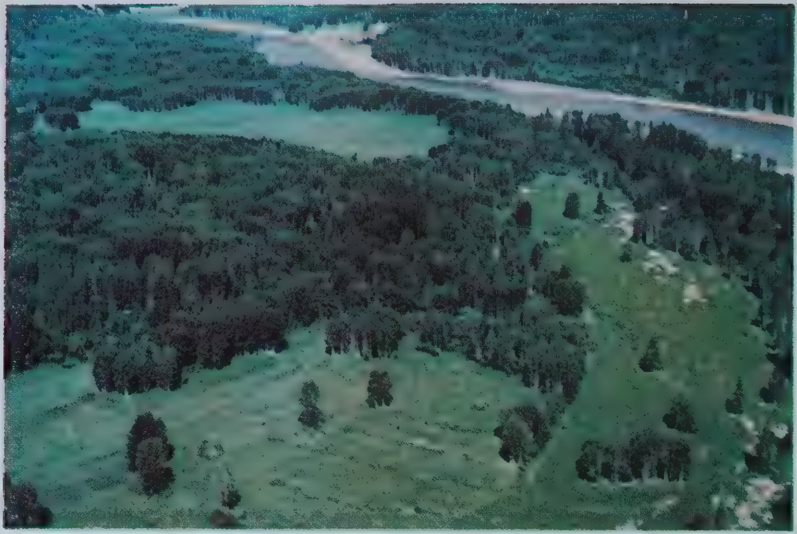

Photo 4.13 Irregularly shaped openings in the forest are visually desirable, especially when clumps of aspen soften the treed edge.

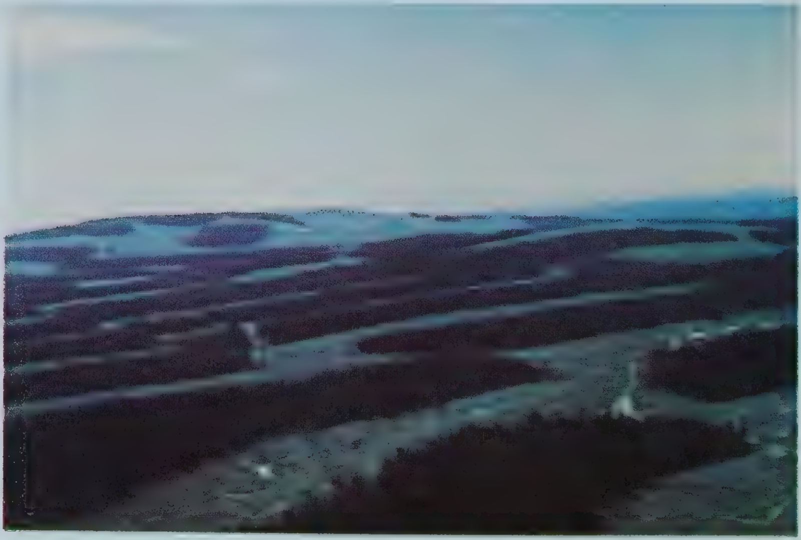

Photo 4.14 Elongated clearcuts adhering to contours are visually pleasing. Normally, streamside vegetation would link residual areas together.

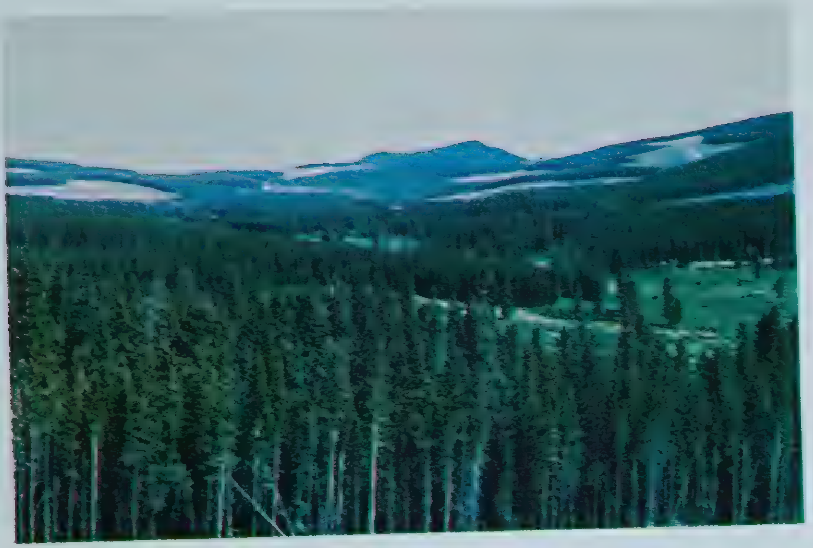

Photo 4.15 Smaller clearcuts are in sympathy with scale of area.

Photo 4.16 Large clearcuts occur in the lower foothills. Natural edges have frequently been maintained. Stream and river edges provide visual continuity and diversity.

Photo 4.17 This road has good vertical and horizontal alignment, which blends with land forms. Treed buffer zones create good sequencing of open and closed views.

Photo 4.18 This road alignment yields a diversity of foreground, middle ground and background views. Right-of-way width varies and forms a natural edge.

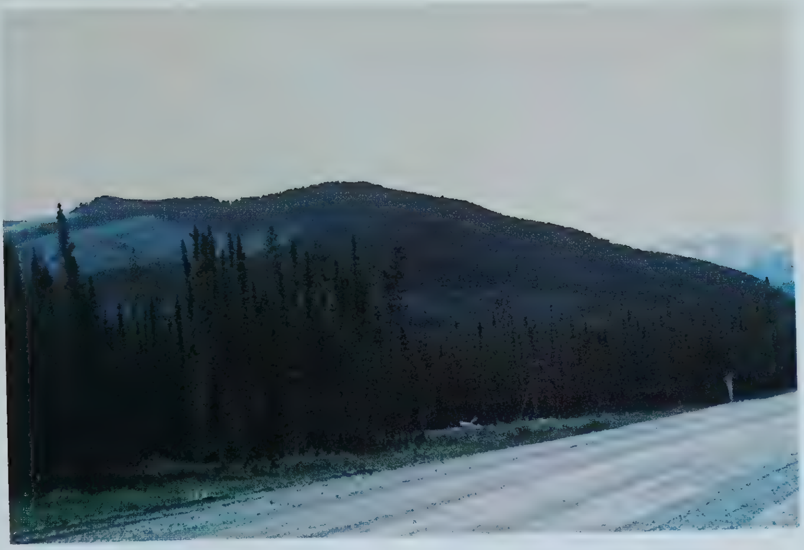

Photo 4.19 Excellent road buffer zone is in area near Hinton.

Photo 4.20 This main haulroad has excellent road edge planting and maintenance. Irregular right-of-way edge results in high visual interest.

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CHAPTER V

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The following conclusions are drawn concerning the project area. Some of these may apply to forest lands elsewhere in Alberta, but no special knowledge of these lands is claimed.

The Environment

C-1 The single adjective which best describes the project area is "VARIABLE". Whereas a nine million acre tract in northern Alberta would be more homogeneous, this area presents enormous variation in geology, climate, hydrology, vegetation, habitat, scenic values, and land-use objectives. These are described in Chapter II and become obvious upon examination of the map overlays in Volume 2.

C-2 A single set of procedures under forest management will not adequately cover all variations which will be encountered. Local interpretation and modification are obviously essential.

Forest Management

C-3 The Forest Service in its relatively short life has set worthwhile objectives for Crown forest lands, and has successfully advocated legislation, regulations and tenure systems for attainment of these objectives. Related legislation of other departments in government is generally in harmony. Much of this legislation and regulation is too recent for observation of results on the ground.

C-4 Forest inventory, allowable cut calculations, and resource inventories of many other kinds urgently need improvement and modernization, but no evidence of exploitation beyond sustained-yield capacity of the forests was found.

C-5 Forest Service staff and facilities at Edson, Grande Prairie, and Whitecourt are reasonably effective, but will require strengthening and added continuity of staffing to carry new responsibilities, resulting from expansion of forestry and other land uses.

C-6 The project area is subject to lightning and man-caused fires which could cause serious losses, and therefore requires maintenance of an effective AFS protection establishment. Future AFS expansion, however, is needed in timber management and land management staffing at all levels.

Forest Hydrology and Wildlife Management

C-7 Watershed and game habitat quality has declined gradually since heavy clearcutting began in the project area. This decline will be arrested by the growth of new timber crops, and can be reversed in future by improvements in forest land management.

C-8 Wildlife habitat (chiefly for big game) merits greater attention on the project area, applied at key locations which require more explicit identification.

C-9 Fish habitat also merits greater attention, mainly in connection with road-stream crossings.

Roads

C-10 Overall transportation planning within the Project Area is poorly coordinated. The Department of Highways, the Alberta Resources Railway, the Alberta Forest Service, and forestry, petroleum and mining companies appear to have separate and uncoordinated transportation facilities.

C-11 The Alberta Resources Railway is currently of no use to the forest industry because of high freight charges. Unless this transportation facility is made available to the forest industry, many surplus miles of parallel main roads will shortly be built, resulting in added adverse environmental impact.

C-12 Individual forest companies have done little long-range transportation planning for their individual FMA's. In many cases, there is only a very general idea of future main road location.

C-13 Generally, forest industry roads are functional and standards relating to grade control and right-of-way clean-up are higher than other regions of Canada. (The main roads of Procter & Gamble and Northwestern Pulp and Power are of exceptionally high standard for log-hauling.)

C-14 Each forest company and Government department has its own set of road standards. Also, each party tends to build for its own principal function with little or no provision for future integration of uses. For example, Alberta Forest Service roads are not generally usable by logging trucks, and the main winter haul-roads of lumber companies are unsuited to use by most recreationists. The resultant duplication of roads is uneconomical and environmentally unsound.

C-15 The principal sources of man-caused erosion are the higher standard roads. As the road standard increases, so does the amount of erosion and sedimentation of streams. This is because of the large cuts, fills and bared areas associated with the higher standard roads.

C-16 Terrain steepness is not as important a criterion in preventing erosion as is soil particle size. Fine grained soils (clays and silts) on gently undulating terrain result in more erosion and siltation of waterways than coarser grained soils on steep hillside settings in the upland areas. For example, steep settings in the Solomon Creek, Torrens River, Berland River and Macleod River Watersheds were found to have very little erosion arising from clearcutting and roads.

C-17 Erosion prevention measures are generally not planned until a problem is known to exist after construction. By this time, much of the damage is done and restoration is expensive or impossible.

C-18 Roadside ditches at stream crossings generally empty directly into the stream, causing unnecessarily large amounts of stream degradation.

C-19 Ditch blocks, off-take ditches and ditch filters are used, but are not always effective in preventing visible erosion. No special priority is given to ditches which are silting fish-bearing streams. Further, ditch erosion prevention is lacking on some roads, particularly in the Musreau Lake area.

C-20 Many cases were found of machine operators being careless in pushing excessive amounts of fill into streams at road crossing sites.

C-21 Abandoned roads and skid roads are "put-to-bed" with waterbars and cross-drains. However, many cases of neglect were found where no treatment whatsoever was applied, creating situations where erosion was unacceptably severe.

C-22 Slash disposal and grubbing on permanent and semi-permanent forest roads are to high standards. However, the Ground Rules (for example, the 25-foot mandatory baring) are unnecessarily inflexible in areas where slash and natural organic material could be used to reduce erosion.

C-23 Limited use is made of compaction equipment, particularly on main winter haul roads. As a result, numerous fill washouts and other roadbed maintenance problems occur.

C-24 In numerous cases, culverts on main roads were found to be poorly designed. Common errors found were culverts too short, too small, too steep, installed too high, installed on incompetent foundations, installed without adequate compaction of backfill, and installed without adequate rip-rap. As a result, fish passage was blocked, excessive erosion was occurring, or total road failure had occurred. Bridges were not found to be interfering with fish passage nor causing undue erosion.

C-25 Culverts on temporary roads are frequently not maintained, and in many cases, are abandoned. As a result, these culverts eventually become non-functional because of icing and routine erosion.

C-26 A common practice on branch roads and skid roads is to use a "gully-block", built of slash and earth fill (or fill mixed with snow). When these "gully-blocks" are abandoned, they eventually wash sediment into waterways.

C-27 All forest companies appear to be negligent in draining logging landings and some temporary spur roads immediately after logging.

C-28 A very limited effort to train employees in environmental awareness has been made by Government and industry. Road foremen, logging foremen and equipment operators display little or no regard for fish passage through culverts, filtering ditch water before it enters a stream, and so on.

C-29 Citizens of Alberta were found to have a poor understanding of their rights of access on forest company roads. In some cases, the posted signs of forest companies are unduly hostile, resulting in misunderstanding, resentment and non-cooperation on the part of the public.

C-30 Future road systems designed to correct these faults would be more expensive in some respects but much cheaper in others. For example, reduction of width, grade, and alignment specifications where acceptable, and avoidance of washout repairs would often produce long-term economies. It is believed that little overall cost increase per mile of road would be associated with the recommendations which follow.

Harvesting

C-31 The range of cutting patterns and cutting cycles called for by new ground rules will not be economically prohibitive for harvesting operations on any important segment of the project area.

C-32 The ground rules will provide improved protection of environmental quality and forest productivity, but will again require local modifications to match local needs.

C-33 Much of the project area lacks adequate mapping as a basis for good planning.

C-34 Pulpwood and sawlog size specifications now differ only slightly. Utilization to pulpwood standards is desirable and feasible throughout the project area. Incentives and valuation formulas are needed to effect this change, and to insure that suitable raw material reaches each type of manufacturing plant.

C-35 The utilization of poplar would have far-reaching economic and environmental effects, probably both good and bad. Potential changes in harvesting caused by utilization of poplar were not part of this study.

C-36 Industry is facing genuine problems with woods manpower. Additional efforts to solve these through innovations in training and mechanization are appropriate both economically and environmentally.

C-37 Harvesting operations on steep terrain are imminent for some companies. Local adaptations of existing methods and equipment are needed for safe, efficient, and environmentally sound operations on this terrain.

C-38 The criterion that no more than 50 percent of the merchantable timber (in a subwatershed) shall be operated in one cut is inadequate for critical subwatersheds, particularly in mountain terrain.

C-39 Similarly the "6 to 8-foot, 20-year Rule" is inadequate on critical game areas, and probably unnecessary on noncritical areas.

Regeneration and Silvicultural Practices

C-40 Virtually none of the forestry or environmental objectives for the project area will be achieved without prompt restocking of cutovers. Virtually all will be furthered to some extent by success of restocking.

C-41 If restocking commitments made under the new ground rules and other requirements can be kept, restocking will be secured. Some improvements over past restocking results will be needed, and as with roads and harvesting, some local interpretation of ground rules will be necessary.

C-42 Conditions for restocking are not ideal on the project area. Unaided natural restocking, without post-harvesting treatment, will be rare on spruce sites but more common on pine sites.

C-43 Regeneration survey procedures are generally effective. Standards set for satisfactory restocking are arbitrary, but appear sound. Long-term field tests of their validity are needed.

C-44 Partial cutting methods will be of marginal profitability and will be more successful in regenerating spruce than pine. These methods will nevertheless be necessary locally on highly sensitive sites, for preservation of watershed, aesthetic, and other values.

C-45 Mechanical scarification is an effective preliminary treatment for natural or artificial reforestation. As currently practised, it has no serious adverse effects on the environment. Prescribed slash burning is less effective, but may at times be necessary on steep terrain.

C-46 Past attempts at artificial seeding have been extensive in Alberta, but largely unsuccessful. Current plans call for heavy reliance on this technique. Possible improvements need to be tested immediately.

C-47 Planting on the project area has been on a small scale until recently, and has undergone a series of technical innovations. Field survival to date has been unsatisfactory.

C-48 Plantation failures are often attributable to a whole range of planning, supervisory, and technical faults, starting in the nursery and continuing into the field. Climatic and growing conditions in the field are severe enough that mortality will often result from such faults.

C-49 Container planting systems show considerable promise, but must still prove up in tests of long-term survival and juvenile growth. Cost per established seedling is a better test of these than cost per seedling ready for outplanting.

C-50 Bare-root planting is the only artificial reforestation technique which shows promise of attaining the ten-year juvenile height growth for spruce which the ground rules require for operation on a 20-year cutting cycle.

C-51 Quantity and quality requirements for planting stock of all kinds will expand very rapidly in coming years. Forest Service proposals for new and autonomous tree nurseries are essential. Failure to produce high-quality planting stock in quantities ordered by companies would nullify their reforestation commitments and impair Forest Service credibility.

C-52 Protection of young stands is provided for satisfactorily in relation to other needs.

C-53 The only stand improvement measure presently justifiable on a fairly large scale is juvenile spacing of overstocked pine regeneration.

Recreation

C-54 The present trend suggests far larger demands for, and use of, forest-oriented recreational settings and facilities in the future than is evident in the project area today. This trend requires that recreational and aesthetic values be considered as a "full partner" with timber harvesting and other demands in the use of project area resources.

C-55 Recreational and scenic resources tend to be more plentiful in the southern and western portions of the project area and along certain travel and waterway zones. It is concluded that the use of zonation as illustrated in the Visual Quality Map in Volume 2 represents an acceptable approach to resolving the general priorities of land use vis-à-vis recreation and economic timber harvesting. In Zone 1 of the Visual Quality Map, recreation and scenic considerations should have priority while in Zone 5 timber harvesting would be constrained only by good environmental practices as embodied in the Ground Rules and the Alberta D.O.E. Land Conservation Guidelines. The access created by timber harvesting will be used by others, hunters and fishermen mainly, whose right of access to Crown land needs to be recognized and accommodated by industry and government.

C-56 The recreational resources of the project area are mostly of a dispersed nature. This implies that recreational spaces need to be relatively large. This also means that the few sites that can support intensive recreation are of major importance in planning.

C-57 A need is recognized for more Provincial Parks in areas, particularly in proximity to lakes that have the potential for intensive recreational use. A similar requirement exists for the reservation of more Forest Recreation Areas.

C-58 Some recreational facilities within the project area illustrate poor planning (such as the loss of valuable shoreline forest in the Wildhorse-Kinky Lake Region). Damage from overuse is also evident (for example at the Two Lakes campground) and results in changes in soil structure and composition as well as in vegetation.

C-59 The present recreational facilities, in some cases, reflect a lack of understanding of user needs. For example, the Recreation Regulations prohibit the storage and dressing of game on Forest Recreational Areas (FRA), yet the dominant use of the Shuttler Flats campgrounds is thought to be from fall hunters.

C-60 From a scenic and aesthetic standpoint, some sub-optimal roadway treatments were observed, including overly-wide and straight bared areas along roads, delays in roadway and hillside clean-up, and unsafe campground-roadway locations.

Aesthetic Considerations

C-61 Existing campsites are in many cases poorly laid out and unnecessarily unattractive. Very poor use is made of edge quality, signs, and the location of facilities in relation to the natural setting.

C-62 The viewing quality from main travel corridors generally increases traveling from east to west or, as indicated on the Visual Quality Map in Volume 2, when moving from Zone 5 to Zone 1. The views are a composite of a number of variations in landforms and land patterns. Superimposed on these landscape views are foreground views of mining sites, recreation sites, timber harvesting areas, and urban roadside developments. Future development along these corridors should be related to these scenic values.

C-63 Undesirable visual impacts noted within project area forest road systems, where recreational or aesthetic values are high, were:

- inadequate road edge cleanup;
- excessively long road tangents;
- poor location or buffering of borrow pits;

- road edge drainage problems;
- poor interfacing of bridges to the existing natural edge;
- inadequate road alignment in relationship to existing contours, land forms, and vegetative patterns.

C-64 Visual effects related to past harvesting operations are:

- inadequate buffer zones around the edges of lakes and other designated recreation areas;
- straight lines on clearcuts which tend to dramatize the setting by cutting across natural contours;
- large clearcut areas adjacent to the Grande Cache road, unrelieved by foreground vegetation clumps;
- snags or single trees, left in clearcut areas that do not appear natural to the site.

Summation

C-65 It is obvious that the land management requirements now set for the project area create entirely new challenges for the forest industry and the Forest Service. Measured in context with the dollars per acre realized in harvesting, these requirements are as demanding and costly as any established elsewhere on Crown lands in Canada. Because of the importance of renewable resources other than timber, most of these requirements are essential for maintenance of an acceptable environment. Little will be achieved by establishment of the requirements unless they can be effectively implemented at the field level.

5.2 Recommendations

The recommendations which follow are believed to be necessary, practicable, and justified by modern land-use objectives for the project area. Although none of these recommendations are considered unimportant, certain of them are clearly more basic, and require implementation more urgently, than others. These more basic and urgent recommendations are marked with an asterisk (*).

All recommendations are directed primarily to the Department of Lands and Forests, subject to consultation with the Department of the Environment and other Departments of the Alberta Government.

Forest Management

*R-1 Expand Forest Service expertise and staffing to permit realistic assignment of new land management responsibilities.

R-2 Modify staffing policies to ensure continuity of key professional staff at each forest. Emphasis on the involvement of experienced road engineers and silviculturists for close supervision of industry road and reforestation programs is suggested.

R-3 Improve career incentives for the timber and land management technicians and foremen who support the professionals. Assign field inspection and reporting responsibilities to qualified Ranger staff. These recommendations do not imply reduced status for AFS protection or other services but rather strengthening in the fields concerned with land management.

*R-4 Stimulate Forest Service-Industry liaison, joint ground inspections, seminars, and enforcement of ground rules and A.O.P.'s. Encourage competent staff to use existing authority to make local modifications to blanket rules.

*R-5 Provide for company or AFS modernization of forest inventory and forest management plans, to equal standards, for all parts of the project area. This would call for detailed mapping and summaries concerning most of the items covered by the map overlays in Volume 2, but would particularly emphasize:

- topography and surficial geology;

- forest cover types, with emphasis on acreages by age-class within drainage units;

- forest site classification.

R-6 Establish and use the option of periodic revisions of ground rules and specifications to incorporate new knowledge.

R-7 Promote applied research along useful lines, in cooperation with Industry and the CFS. Formation of a Regional Forest Management Research Committee, with wide government and industry representation, would probably be a constructive approach to this. A similarly-constituted Committee in British Columbia has furthered programs which will provide solutions to pressing management problems.

R-8 Create opportunities for publicizing the aims, commitments, achievements, and unsolved problems of Provincial Forest Management programs. Forest Management issues are of public concern, and require balanced public reporting.

*R-9 As the Department of Lands and Forests, act as the principal authority for land use in the project area, where forest management is the principal land use. This would entail responsibility for:

- preparation of a forest zoning plan following principles similar to those of a municipal zoning plan;

- soliciting recommendations and proposals from other departments of government such as Highways, Mines and Minerals, Environment, Provincial and National Parks, and Fish and Wildlife;

- consulting with interested parties concerning development plans or annual operating plans, by means ranging from informal discussions to public hearings;

- making final decisions, subject to appeal, concerning new land uses or developments.

R-10 Give serious consideration to the land use approach in use in the Prince George Forest District of B.C. for the processing of Cutting Permits (roughly equivalent to Alberta's A.O.P. areas). The Prince George system is as follows:

- Forest Service coordinates assembly of overlay maps showing soil stability, timber, wildlife habitat, fish habitat, and other features like those in Volume 2 of this report. This local information is provided by specialists in the fields concerned.

- Operator outlines a Cutting Permit area intended for future operations on these maps, and describes planning, cutting sequence, and other particulars.

- Combined comments and constraints are returned to the Operator, who completes cruising, layout, and formal cutting permit application.

- Forest Service completes any necessary further consultations with specialists and issues Cutting Permit subject to any final restrictions.

The essential features of this approach are that the Operator is given constraints around which the application must fit, before his major effort is expended, and that all interested government agencies are systematically canvassed for opinion at an early stage.

Forest Hydrology and Wildlife Management

R-11 Proceed with preliminary classification of streams (like that on the NWPP Lease) throughout portions of the project area where harvesting operations are planned.

*R-12 Following more detailed resource inventories and mapping projects recommended in R-5, draw new operability boundaries which delete certain areas from normal timber production (exclusive of special salvage or sanitation cutting following fire or other damage). The suggested deletions are:

- all forests above some critical elevation, tentatively 5,500 feet;
- sensitivity codes 7 and 8 as defined in Table 2.2;
- sensitivity codes 6, 7 and 8 as defined in Table 2.2, within subwatersheds denoted "H" on the Watershed Sensitivity overlay in Volume 2, and in Table 2.5;
- additional areas of known wildlife or aesthetic importance.

Inventory and annual allowable cut calculations for the remaining operable area would then be prepared. A reconciliation between committed annual cut and this new allowable cut would be necessary, but in general it is predicted that new allowable cut calculations based on better inventory data would be at or near the existing levels for the various tenures, and that harvesting economies would be made possible.

R-13 On the basis of empirical testing like that in the Tri-Creeks Watershed, establish objective standards for water quality, temperature, and flow, accompanied by monitoring stations to provide continuous readings. Permit continuing timber harvesting operations so long as acceptable readings are recorded, but curtail operations when standards are not maintained. This general concept is superior to arbitrary or blanket regulation, but the standards, procedures, and instrumentation will not be available immediately.

R-14 Record and compile acreages denuded within each of the 10 or 12 major drainage basins of the project area. Control vegetation on these basins for purposes of downstream flood prevention. If combined devegetation within any one of these from cutting or any other agency exceeds 10 percent during a decade, take steps to limit further cutting or to accelerate revegetation.

*R-15 Set standards for adequate revegetation for watershed protection (as opposed to coniferous restocking standards). For example, 80 percent green vegetation on sample "plots" located on midsummer color photography is suggested as an acceptable revegetation standard. Ocular estimates from the air would be an acceptable, but a less conclusive alternative. Using updated management maps or new photography, monitor the proportion of each subwatershed currently under vegetative cover by these standards. Limit future cutting in sensitive subwatersheds under annual operating plan procedures, so that this proportion is kept above 90 percent.

*R-16 Modify the "6 to 8-foot, 20-year Rule" as follows:

- Invite the Fish and Wildlife Division to select "special game" areas totaling a maximum percentage (say 20 percent) of the productive timberlands of each tenure, which represent the most important big game habitat.
- Require treatment of special game areas specifically to provide shelter to the species in question. This might entail mandatory strip-cutting, additional lengthening of the interval between first and second cuts, areas of partial cutting, or combinations of these and other measures taken for specific results.
- Relax the "6 to 8-foot, 20-year Rule" on the remaining forest area, but retain all other rules respecting restocking.

Roads

*R-17 Assign the preparation and administration of a master road system plan to the Alberta Forest Service. This plan should reflect long-range multiple road use including intensive recreational use in areas designated in Volume 2 of this report. Further, the plan should provide for an economy in quantity of roads; joint public and industry use should be sought wherever possible. For example, the Alberta Department of Highways should refrain from building a new highway parallel to the Procter & Gamble trunk road south of Grande Prairie. Finally, the plan should include provisions for reducing and consolidating the present quantity of main haul roads used by the four companies operating out of Grande Prairie.

Each FMA holder should be required to prepare a long-range transportation plan which conforms with the Alberta Forest Service master road system plan.

The Alberta Resources Railway should encourage rail hauling of forest products, particularly on long hauls where new truck roads would be required.

*R-18 Assign to the Alberta Forest Service the establishment of uniform forest road standards which would apply to all industrial roads. In cases where a particular company cannot economically justify the standard of road required, the AFS should insist on vertical and horizontal alignment which will allow the ultimate standard of road to be achieved without major relocations when improvements are made.

The uniform road standards recommended below (Table 5.1) is broad enough and flexible enough to meet the needs of individual parties without causing significantly greater costs. The main objective should be to work toward a common master road system so as to avoid duplication, obsolete roads, and consequent adverse environmental impact.

TABLE 5.1

SUGGESTED UNIFORM ROAD CLASSES AND MINIMUM STANDARDS

CLASS I (Primary)	Permanent main road, available year round.
CLASS II (Secondary)	Permanent branch road, generally available 10 months.
CLASS III (Tertiary)	Lateral access through cut-blocks, 10-year average term, limited access during wet periods.
CLASS IV (Temporary)	Temporary truck road within or between cut-blocks (2-year average life).
CLASS V (Access)	Access road for light vehicles (e.g., roads to lookout towers).

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ITEM	ROAD CLASS				
	I	II	III	IV	V
Safe Design Speed - mph	55	45	35	25	-
Substained Speed - mph	40	30	20	10	-
Maximum Degree of Curvature	5	8	13	25	-
Sight Distance - ft.	600	450	300	-	-
Max. favorable Grades - %					
Sustained	6	7	8	10	12
Pitch	8	8	10	12	14
Max. Adverse Grades - %					
Sustained	4	4	6	6	12
Pitch	5	6	8	8	14
Right of Way Width - ft.	132	100	80	66	66
Surface Width - ft.	32	28	20	18	16
Maximum Bared Width - ft.	90	85	60	30	30
*Cutslopes - Cotan	1-1/2:1	1-1/2:1	1-1/2:1	1-1/2:1	1-1/2:1
*Fillslopes - Cotan	2:1	2:1	1-1/2:1	1-1/2:1	1-1/2:1
Bridge & Culvert Strength - tons	150	150	100	100	5
Engineering					
Plan	Detailed Design	Detailed Design	Rough Plot	Traverse Only	Traverse Only
Profile	Detailed Design	On cuts & fills over 5ft.	On steep grades only	On critical grades only	None
R/W Stakes or Flags	Both Edges	Both Edges	Center Only	Center Only	Center Only
Construction stakes	Cut, fill & Centerline complete	Centerline & all cuts & fills over 5 ft	Only at critical areas	Only at critical areas	None

*Subject to soil erodibility at individual sites. On very sensitive terrain, cuts over 5 feet should be 2:1, fills over 5 feet should be 3:1.

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*R-19 Procure detailed topographic and surficial geology maps for use in locating forest roads. These maps will identify sensitive terrain which should be avoided, or given special erosion prevention treatments. These prevention measures could include:

- avoiding valley bottom locations;
- selecting stream crossing sites which have stable approaches;
- restricting size of cuts and fills to an absolute minimum;
- planning construction on sensitive terrain to coincide with dry or frozen seasons;
- appropriate design of cutslopes and fillslopes in sensitive terrain.

In all cases, road construction should be planned so as to avoid erosion problems prior to actual construction.

R-20 Continue the basic safeguards contained in the present Consolidated Ground Rules which relate to road proximity to lakes and streams, but exercise options for local modification to recognize special local needs.

R-21 Approve only those future road locations, as outlined in Annual Operating Plans, that do not degrade ungulate (particularly winter feeding grounds or breeding grounds) or fish habitat, or areas of prime recreational importance. Companies should be required to illustrate that ungulate and fish habitat have been identified and avoided.

R-22 Continue the current rule that right-of-way slash be burned and buried under the road embankment, in borrow pits, or below the original ground level.

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*R-23 Relax the current requirement that an area 20 to 25 feet wide alongside each road be bared to mineral soil. In its place, allow road builders to use duff, stumps and some slash for erosion prevention purposes. In special cases where fire risk is considered severe, the AFS should require a designated width be bared to mineral soil.

*R-24 Insist that all areas which have been bared to mineral soil be revegetated within not more than two years of the date of construction. Where artificial seeding is used, fire resistant species should be utilized.

R-25 Ensure that cut and fill slopes are stabilized not later than two years from the date of construction. Flexibility should be allowed on the method of stabilization used. Depending on local conditions, the methods which can be used include: more gentle slopes, terracing, revegetation, or a combination of the foregoing.

*R-26 Ditch standards are adequate at the present time except for the use of ditch blocks and off-take ditches. Ensure that ditch water is channeled away from all roads whenever possible, but not less frequently than as follows:

	Distance Between Off-take Ditches	
Percent Road Grade	Regular Terrain	Sensitive Terrain
0- 5	800 feet	400 feet
5-10	600 feet	200 feet
10-15	400 feet	150 feet
15+	200 feet	150 feet

Ditch blocks should be made of competent material such as rock, coarse gravel compacted with clay, or compacted clay stabilized with vegetative cover, or rock-filled gabions.

All ditches which enter a fish stream, or any stream which is likely to carry sediment to a fish stream, should have a minimum of 50 feet of brush filter. This brush filter can be natural if available; otherwise, it should be artificially made from stabilized slash filters.

*R-27 Give more attention to erosion prevention on temporary haul-roads and skid-roads. This will require an integrated effort covering planning, location, construction, maintenance, and restoration. The following criteria should be used as guidelines:

- In summer operations, temporary crossings ("gully-blocks") of gullies or intermittent streams should be built mainly of logs and brush piled crosswise. The depth of soil fill pushed over the log fill should normally not exceed 2 feet.
- In deciding whether a culvert or "gully-block" should be used, the following information should be obtained: size of watershed behind the "gully-block", distance downstream to a possible fish stream, fineness of soil used in "gully-block". In all cases where sediment could reach a fish stream, the decision should be to use an appropriate size metal or wooden culvert.
- In winter operations, temporary crossings should be made of snow, or if logs and earth are used, the conditions outlined in the previous paragraphs should apply.
- The percentage of any clearcut whose long-term productive capacity is downgraded by stripping or compaction on roads, skid-roads and landings should not exceed 5 percent.
- The practice of utilizing old seismic lines for road locations should be discontinued unless the seismic line is well located to prevent erosion.
- All skid-roads and haul-roads which are "put-to-bed" should have all drainage structures removed, and on grades over 5 percent, effective "push-ups" should be made each 200 feet to prevent water movement along compacted surfaces.

- Re-establishment of normal drainage patterns on roads and landings should be undertaken immediately after logging. If frozen ground prohibits drainage re-establishment, the required work should be done the following summer.

R-28 Ensure that gravel borrow from within the high water wetted perimeter of any stream or within 200 feet of any stream is prevented except after approval of a Government fisheries biologist. Further, gravel pits constructed under these terms should be engineering design items.

R-29 Favor the use of well-stabilized bridges on all fish bearing streams, except where depth of fill or other criteria render a bridge impractical.

*R-30 Give more attention to stabilizing the inlets and outlets of culverts. Gabions, large size rip-rap or concrete aprons should be used to prevent erosion of fills and stream bottoms. Plunge pools should be prevented.

Culvert sizes on roads of 10 years' life or more should be adequate to handle a 50-year-frequency flood without causing major washouts. Those on roads of shorter life should be adequate to handle a 25-year-frequency flood.

Culverts should be designed to allow passage of fish where fish are known to exist. Normally, this will mean that culvert water velocities should not exceed 5 feet per second for longer than one week. However, special streams may require more stringent criteria to conserve fish species.

R-31 Insist that streams which are known to have fish, and which are currently blocked by culverts, be rehabilitated such that fish passage is assured.

R-32 Continue with the present system of granting Licences of Occupation for all main forest industry roads. All other roads should be approved in Annual Operating Plans. Easements should be avoided.

*R-33 Direct industry to scarify and destroy roads which are no longer used. Roads which will not be used for over 5 years should be thoroughly "put-to-bed". (See also R-40.)

R-34 Continue to use public road closures for reasons of safety or for fire or road damage prevention, but exercise restraint in frequency of closures, as is done at the present time.

R-35 Permit forest industry hauling on public highways and AFS roads under realistic terms. Licensing, fuel tax, and load restrictions should be relaxed whenever feasible.

*R-36 Require each forest company operating in the Project Area to undertake environmental awareness training for its field supervisory staff.

*R-37 Ensure that Alberta citizens understand their rights of access on industrial roads. Road signs should be courteous, not threatening.

*R-38 Conduct surveys to confirm identity of recreation and scenic roads (see Visual Quality Overlay, Volume 2), and investigate the feasibility of establishing dual-purpose or multi-purpose roads on a cost-sharing basis.

R-39 Require use of aesthetic principles in construction or improvement of major recreational roads, such as:

- imaginative right-of-way clearing with variable width, curved edges, clumps of retained vegetation, and clearing for scenic outlooks;
- meticulous slash disposal and edge clean-up, beyond the requirements of fire protection;
- borrow pits screened from view and landscaped after abandonment.

R-40 Maintain present provisions for obliteration or "putting-to-bed" of unused roads, subject to AFS assumption of administration and maintenance of roads selected for recreational access.

R-41 Standardize road sign information identifying recreation roads, giving mileages, and clarifying safety and traffic restrictions.

Timber Harvesting (recommendations are in addition to those relating to harvesting but made elsewhere)

*R-42 Undertake an interdepartmental 2-year program for compilation of preliminary maps showing zonation of soil stability and slope, watershed sensitivity, fish and wildlife habitat, and visual quality, for the guidance of industry in preparing A.O.P.'s along lines described in R-10.

*R-43 Interpret ground rules strictly in planning the pattern, size and shape of new cut blocks, and apply the constraints of zonation maps (R-42). Strip cuts in spruce types may prove too wide for prompt restocking. Nevertheless do not make premature arbitrary changes in ground rules until the success or failure of regeneration is unmistakably demonstrated. Similarly, the large spruce patch cuts of PG may fail to restock adequately, but the agreed terms should stand until conclusive results are obtained.

R-44 Take steps before cutting to identify significant occurrences of advance conifer regeneration for avoidance during skidding and scarification. This applies mainly to spruce types, where establishment of new seedlings is often difficult.

R-45 Enforce harvesting rules and A.O.P. terms by means of frequent inspections and reports, and by positive use of deposit monies.

*R-46 Encourage full utilization to pulpwood size standards on both pulpwood and sawlog operations. Governmental regulation to this end must be accompanied by fair valuation mechanisms (see Section 3.3.1) for use in intercompany sale or exchange of wood.

*R-47 Encourage use of cooperative woods harvesting training schools which foster permanence of harvesting employment, safety, and good workmanship. These qualities in turn will foster good environmental care.

*R-48 Cooperate with the industry in local adaptation of methods and equipment for harvesting steep ground, and also for remote winching of timber from within protective belts.

R-49 Intensify and formalize investigations of harvesting cost along the lines suggested in the study. Review cost changes at one-year intervals rather than the existing two-year intervals, during periods of rapid change.

Silvicultural Practices

*R-50 Continue enforcement of the scheduling of regeneration surveys and NSR treatment agreed to by quota holders with particular care commencing in 1973, with the commencement of regeneration surveys of 1966 cutovers.

R-51 Establish spacing trials and other research projects to test validity of the restocking standards under varying conditions. Cooperation between the AFS and the CFS on accessible company tenures is suggested.

*R-52 Provide complete documentation on success or failure of regeneration. Such basics as map location, detailed cutting history, post-cutting treatment, regeneration surveys, and subsequent changes in the degree of stocking are not readily available in most cases. It is understood that a record-keeping system covering every recently cut block in Alberta is being established. The cost and effort of maintaining this in accurate form, and based on field information, will be heavy, but will not be regretted.

R-53 Give consent to the NWPP proposal for a trial of the Progressive Clearcut System, on a single compartment. The compartment should be of average sensitivity to damage of watershed, habitat, and related values. Scientists should be asked to monitor the effects closely throughout an entire cutting cycle, and the company should agree to correct damages associated with roads, to retard cutting, or to accelerate restocking in cases where monitoring indicates a need. This would be considered a trial of specific applicability in individual subwatersheds, not of general applicability throughout the NWPP lease.

R-54 Encourage PG to test several scarification systems complementary to the more mechanized PG operations, in order to determine which is best. This does not imply exemption from normal restocking commitments on test areas.

R-55 Promote early cooperation with the companies concerned to develop sound marking and partial cutting methods for stands of high visual, recreational, or wildlife significance. Subsidization of operations in these stands should not be ruled out.

*R-56 Maximize AFS participation during each year in Supplementary Reforestation programs with the companies concerned, to take full advantage of company commitments. The AFS rehabilitation effort elsewhere on Crown lands should also be maximized during the present period of high Crown forest revenue.

*R-57 Immediately conduct exhaustive tests of artificial seeding on well prepared sites, using seed quantities, operation methods, and application methods which are

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theoretically more promising than those used in the past. Preliminary results of several replications should be available before heavy reliance is placed on company operational seeding projects. With the availablility of ample seed and modern scarification methods, seeding may still become an important and successful restocking technique on the project area.

*R-58 Immediately establish new AFS tree nursery facilities exclusively for forest planting. These must be capable of bare-root and container stock production of high quality and in substantially increased quantity, commencing in 1975 at the latest. Shortages or low quality of AFS stock still encourage deferment of industry and AFS planting programs at present.

R-59 Encourage serious study of the merits of a Procter & Gamble or joint industry-operated tree nursery at Grande Praire, parallel to that at Hinton. The terms for reimbursement of industry production costs provide healthy incentives for improvement of technology in both industry and government nurseries. Local planting needs justify establishment of a Grande Prairie nursery, and would provide opportunities for perfecting the best local practices.

R-60 Require close and detailed study of plantation survival and development, parallel to studies of natural restocking, especially over the next decade. Planting costs must be minimized, but much depends on the choice of systems which will establish new crops reliably, regardless of minor cost savings.

R-61 Develop a practical system to provide "dead" shade for planted or seed-spotted spruce on exposed sites. It appears that this would improve survival and growth at a cost easily justified in comparison with the cost of repeated reforestation failures on these exposed sites.

R-62 Regulate the use of chemical fertilizers or biocides on silvicultural programs.

R-63 Cooperate in local development of practical and mechanized systems for reduction of pine stocking on old or recent burns.

R-64 Continue AFS projects for conversion of poplar stands to mixedwood stands.

Recreation

*R-65 Increase Alberta Forest Service budget and man-year allocations for recreational planning and development so that recreational and scenic opportunities can be recognized and developed in concert with forest development.

*R-66 Train AFS personnel in the recognition of good recreational and scenic opportunities, valuable wildlife habitat, and possible historical and archaeological sites.

R-67 Improve the design of Forest Recreation Areas.

R-68 Install riverside campsites and launching facilities for the use of waterways for recreation.

R-69 Undertake detailed study of the cost in forest production of deleting the Folding Mountain area of 38 square miles from Management Unit E5. If this cost is minor, this should be done.

R-70 Expand the Kakwa Natural area around Kakwa Falls to conform to natural boundaries. A detailed study should establish boundaries which would permit use of the concepts of protection of the skyline, protection of watersheds, and protection of wildlife habitat.

*R-71 Delineate and map in detail the visual corridors of important travel routes (roadway, waterway, and trail) as a first step in the management of visual and recreational resources along high use areas. This may indicate a need for withdrawals from cutting tenures similar to those already made surrounding lakes in the NWPP lease.

R-72 Create a Special Management Zone in the vicinity of Two Lakes. This area should be subjected to intensive forest management in recognition that recreation and scenic appeal is a major land use. The Skyline concept of management should apply, with small clearcut settings fitting natural contours within viewing areas. Access roads in this area should be restricted to short tangents, variable-width clearing, and ridge-top or valley floor locations.

R-73 Investigate costs and benefits of creating a limited-access recreation area in the vicinity of Mountain Park and Cardinal Mountain.

R-74 Create an AFS forest recreation planning strategy complementary to that of the Department of Highways. This should provide for:

- user-oriented intensive-use sites close to population centers and along primary routes subjected to tourist and sight-seeing traffic;
- small campsites dispersed widely to accommodate hunters and fishermen and to avoid overuse. The number of these campsites should be large enough to permit rotating closure if required by logging operations;
- road improvements and limited service sites keyed to a gradually increasing environment-oriented recreational activity along the portal approaches to the mountains and along secondary forest roads culminating in wild backcountry.

General

R-75 Sponsor environmentally-oriented seminars, workshops, field trips, and short courses for attendance by personnel at several levels in the Forest Service and Industry.

Summation

It will be noted that not many of the above recommendations entail establishment of additional rules by the AFS. A great many, on the other hand, are for the purposes of implementation as follows:

- furthering the implementation of regulations already on the books, to achieve well defined objectives;
- ensuring that an understanding of the objectives and principles committed to by the land managers reach the operating levels;
- speeding up the transition from purely forest management to land management of forests, with much greater recognition of all the resources which deserve attention.

5.3 Reconciliation of Costs

It is difficult to predict in detail the additional costs associated with adoption of the above recommendations. In general, however, the following observations appear valid:

RC-1 Substantial increases in government inspection, supervision, liaison, and research activities are recommended, amounting to land management at an entirely new level. Substantial increases in Forest Service staffing within the project area are corollary to this. It must be assumed that the government is prepared to accept a gradual increase in per-acre management costs. No estimates of absolute increases in Crown costs, or of the scheduling of these increases, are made. Recent expansion of annual cutting (PG's operations) and substantial increases in forest revenues evidently will create funds which will permit this expansion of government budgeting.

RC-2 The cost of establishing even an inferior road network for timber harvesting is already a major segment of harvesting costs. The cost of maintaining poorly built roads and the vehicles using them is also high. In view of this it is strongly felt that the recommendations for improved planning and construction practices entail no additional cost per mile of harvesting road built. If a given road is built for dual or multiple land uses including timber harvesting, and is more costly because of this, then an equitable basis for cost sharing must be set up such that added costs to the harvesting industry are negligible.

RC-3 The new rules will entail harvesting of relatively narrow strips and will in some cases necessitate lengthening of the normal 20-year cutting cycle. The main added cost of these will be in the increased inventory of unamortized roads. The associated additional cost will vary greatly, but has been calculated for representative conditions at $0.17 per cunit of annual cut.

The cost of retaining protective green belts is considered minor. Deciduous stands commonly occupy stream side sites, and would not be cut in any event. The winching of merchantable timber in these belts beyond the limits of machine travel will result in reduced volume recovery, but not zero recovery.

RC-4 Rough estimates of the cost to industry of reforestation, based on a 10-60-10-20 percentage distribution of untreated, scarified, scarified and seeded, and scarified and planted cutovers, is $1.23 per cunit cut. This includes a minor additional cost for juvenile spacing. Calculations of current harvesting costs (Appendix III-11) already include current average reforestation costs of $0.66 per cunit for scarification and $0.46 per cunit for planting. These were agreed to in the past and are expected by the industry. On this basis the added cost of treatments recommended is $0.11 per cunit cut ($1.23 - $1.12).

RC-5 The added cost to industry of all improvements agreed to under new ground rules or recommended is estimated as follows:

Source	Added Industry Cost, $/Cunit	
	Pulpwood Harvest	Sawlog Harvest
Improved Practices on Future Roads	nil	nil
Industry rehabilitation of existing roads and culverts (1/2 share of cost)	0.10	0.15
Modified cutting cycles and patterns under ground rules	0.17	0.17
Net added cost of cutting on "special game" areas	0.05	0.05
Restocking program	0.11	0.11
Unforeseen contingencies	0.15	0.15
	0.58	0.63

Industry spending in many additional forms might be desirable, but the above levels of added cost appear appropriate at the present developmental stage of the project area. It seems reasonable that certain environmental measures undertaken by the Crown be at Crown expense. Industry would be involved in these as an agent of the Crown, and on an incentive basis rather than a cost basis. An example would be localized partial cutting at Crown instigation, for aesthetic purposes.

RC-6 Current estimates of the funds which may be surplus to all operating costs and acceptable returns are in the order of $2.30 per cunit cut for purely pulpwood operations and $2.20 per cunit for purely sawlog operations. Especially with opportunities for pulp companies to increase returns on sawlog material cut, funds for the measures recommended appear currently available to operators under the conditions assumed.

Annual surpluses will fluctuate in future; requirements for annual environmental expenditures by industry will tend to remain constant. The budgeting of these funds, even in unprofitable periods, is an industry responsibility.